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OF

## THE ASIATIC SOCIETY.

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No. 55.—July, 1836.

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I.—*Translation of a Támba Patra, which was found in a field of the village of Pipliánagar in the Shujálpur Parganá, by a Krisán engaged in ploughing, and presented to Mr. L. WILKINSON, the Political Agent at Bhopál, by the Jagirdár.*

[In a letter to the Editor of the Journal of the Asiatic Society.]

It is incumbent upon the friend of research to contribute every piece of information, however trifling, thrown in his way by accident or opportunity, by which the future researches of our successors in regard to the history and chronology of this country may be, in any degree, promoted. With this view I have thought it proper to forward to you the copy of an inscription on a copper plate lately found at Pipliánagar, in this neighbourhood. For the benefit of the purely English reader, I have added a translation, which, if found correct, you can also insert.

On referring to the Chronological Table of the rájas of Málwá, given in the number of your Journal for December 1835, I find that this plate confirms the Ujjain Inscription in regard to the order of succession of four princes.

Three other copper-plates have since been found at the same village. I have not yet had time to translate, or indeed to decipher them.

L. WILKINSON.

[This inscription does more than Mr. WILKINSON allows, for it adds four important names to the Ujjain list, below that of JAYAVARMA, (see *Chron. Tab.* 105,) and having a date A. D. 1210 to ARJUN the last of the list, it exactly fills the blank between the former prince (1143), and BIRSAL in 1220. We have no space for comments, but we offer our best thanks to Mr. WILKINSON for his valuable contribution.—ED.]

*Transcript of the text in Modern Nāgarī.*

ॐ नमः पुरुषार्थचूडामणये धर्माय ॥  
 प्रतिबिंबतया भूमेः कृत्वा साक्षात्प्रविष्टं ।  
 जगदाङ्गादयन् दिक्षाद्विजेन्द्रो मङ्गलानि वः ॥ १ ॥  
 जीयात्परशुरामोसौ क्षत्रैः क्षुण्णा रणाक्षतैः ।  
 संध्यार्कबिंबमेयोर्वी दातुर्यस्येति ताम्रतां ॥ २ ॥  
 येन मंदोदरीबाष्पवारिभिः शमितो मध्ये ।  
 प्राणेश्वरीवियोगाग्निः स रामः श्रेयसेऽस्तु वः ॥ ३ ॥  
 भीमेनापि धृतौ मूर्द्ध्नि यत्पादौ स युधिष्ठिरः ।  
 वंशाद्येनेदुना जीयात्स्वतुल्यश्च निर्मितः ॥ ४ ॥  
 परमारकुलोत्तंसः कंसजिन्महिमा नृपः ।  
 श्रीभोजदेव इत्यासीदासीमक्रांतभूतलः ॥ ५ ॥  
 यद्यश्चन्द्रिकोदेति दिग्गत्संगतरंगिते ।  
 द्विघ्नृपयशः पुंजपुंडरीकैर्निमीलितं ॥ ६ ॥  
 ततोभूदुदयादित्यो नित्योत्साहैककौतुकी ।  
 असाधारणवीरश्रीरश्रीहेतुर्विरोधिनां ॥ ७ ॥  
 महाकलहकल्पांते यस्याहामभिराशुगैः ।  
 कति नोन्मूलितास्तुंगा भूभृतः कटकोत्खणाः ॥ ८ ॥  
 तस्माद्भिन्नद्विषन्मर्मा नरवर्मा नराधिपः ।  
 धर्माभ्युद्धरणे धीमानभूत्सीमा महीभुजां ॥ ९ ॥  
 प्रतिमभातं विप्रेभ्यो दत्तैर्यामपदैः स्वयं ।  
 अनेकपदतां निन्दे धर्मेयेनैकपादपि ॥ १० ॥  
 तस्याजनि यशोवर्मा पुत्रः क्षत्रियशेखरः ।  
 तस्मादजयवर्माभूज्जयश्रीविश्रुतः सुतः ॥ ११ ॥  
 तत्सुनुर्वीरमूर्धन्यो धन्योत्पत्तिरजायत ।  
 गुर्जरोक्तेर्निर्बन्धी विन्ध्यवर्मा महाभुजः ॥ १२ ॥  
 धारयोद्धृतया सार्द्धं दधातिस्म त्रिधारतां ।  
 सांयुगीनस्य यस्यासिस्तातुं लोकत्रयीमिव ॥ १३ ॥  
 तस्यामुष्यायणः पुत्रः सुत्रामश्रीरथाश्वत् ।  
 भूपः सुभटवर्मेति धर्मेतिष्ठन्महीतलं ॥ १४ ॥  
 यस्य ज्वलति दिग्जेतुः प्रतापस्तपनद्युतेः ।  
 दावाग्निसुमनाऽद्यापि गर्जन्गुर्जरपत्तने ॥ १५ ॥  
 देवभूयं गते तस्मिन्नंदनोऽर्जुनभूपतिः ।  
 दोष्ठा धत्तेऽधुना धामी बलयं बलयं यथा ॥ १६ ॥

वाललीलाह्वे यस्य जयसिंहेपलायिते ।

दिक्पालहास व्याजेन यशो दिक्षु विजृम्भितं ॥ १७ ॥

काव्यगांधर्व सर्वस्वनिधिना येन सांप्रतं ।

भारावतरणं देव्याश्चक्रे पुस्तकवीणयोः ॥ १८ ॥

तेन त्रिविधवीरेण त्रिधापल्लवितं यशः ।

धवलत्वंदधु स्त्रीणि जगंति कथमन्यथा ॥ १९ ॥

स एव नरनायकः सर्वभ्युदयीशकपुरप्रतिजागरणके पिडिविडि ग्रामे  
समस्त राजपुरुषान् ब्राह्मणोत्तरान् प्रतिनिवासिपट्ट किल जनपदादींश्च  
बोधयत्यस्तुवः संविदितं यथा मंडपदुर्गावस्थितैरस्माभिः सप्तषष्ठ्यधिक  
द्वादश शत संवत्सरे फाल्गुणे १२३७

शुक्लदशम्यामभिषेकपर्वणि स्नात्वा भगवंतं भवानीपतिमभ्यर्च्य संसा  
रस्यासारतां दृष्ट्वा तथाहि ।

वाताभ्रविभ्रममिदं वसुधाधिपत्यमापातमात्रमधुरो विषयोऽप भोगः ।

प्राणास्तृणाग्रजलबिंदुसमा नराणां धर्मः सखा परमहो परलो-  
कयाने ।

इति सर्वविमृश्यादृष्टफलमंगीकृत्य मुक्तावसुस्थानविनिगीताय वा  
जसनेयशाखाध्यायिने काश्यपगोत्राय काश्यपवत्सारनैध्रुवत्रिप्रवराय  
अवसाविकदेक्षणम प्रपौत्राय पंडितसोमदेवपौत्राय पंडित जैत्रसिंह  
पुत्राय पुरोहितगोविंदशर्मणे ब्राह्मणाय समस्तोपिग्रामश्चतुःकंकट  
विशुद्धः सवृक्षमपलाकुलः सहिरण्यभागभोगः सोपस्कारः सर्वदाय  
समेतः सविनिक्षेपो मातापित्रोरात्मनश्च पुण्ययशोऽभिवृद्धये चंद्रा-  
कांक्षैवक्षितिसमकालं यावत्परया भक्त्या शासनेनोदकपूर्व्यं प्रदत्तः तन्म-  
त्वा तन्निवासिपट्टकिलजनपदैर्यथा दीयमान भागभोगकरहिरण्य-  
दिकं देव ब्राह्मणभुक्ति वज्रमाज्ञाविधेयै भूत्वा सर्वैरमुष्मै दातव्यं सामान्यं  
चैतत्पुण्यफलं बुध्वाऽस्मदंशजैरन्यैरपि भाविभोक्तृभिरस्तत्प्रदत्तधर्मो  
दायोऽयमनुमंतव्यः पालनीयश्च उक्तंच ।

वज्रभिर्वसुधा भुक्ता राजभिः । समरादिभिः । यस्य यस्य यदा भूमि  
स्तस्य तस्य तदा फलं ॥

खदत्तां परदत्तां वा यो हरेत् वसुंधरां । स विष्ठायां क्रिमिभूत्वा  
पिष्टभिः सह मज्जति इति कमलदलांबुबिंदुलोलां श्रिय मनुचिंत्यं  
मनुष्य जीवितंच ।

सकलमिदमुदाहृतं च बुध्वा न हि पुरुषैः परकीर्तयो विलोप्याः ।

संवत् १२३७ फाल्गुणशुद्ध १० गुरौ रवितमिदं महापंडित  
श्रीबिल्हणसंमतेन राजगुरुणा मदनेन ॥

*Translation.*

To Virtue, the most worthy object of desire to man, hail !

1. May the best of Bráhmans, who gives happiness to the whole universe by accepting a small portion of the earth as an emblem of the whole, give happiness to you.

[Or, may SHESHA, who gives happiness to the whole world, upholding (by contact with) that portion (resting on his head), give happiness to you. Or, may the moon, who gives happiness to the whole world, and who receives (in an eclipse) the shadow of the earth, give happiness to you.]

2. May that PARASHURÁMA, who gave to the Brahmans the whole earth, after it had become red as the setting sun, being drenched in the blood of the race of Cshatriyas prostrated in terrible conflicts, ever be praised.

3. May that RÁMA, who victorious in battle, quenched in the flood of tears, caused MANDODARÍ to shed the fire that burnt in the breast of the virtuous SI'TA, when torn from her consort, give salvation to you.

4. May YUDHISHTHÍRA, whose feet the valiant BHÍ'MA kissed in humility, and whom CHANDRA, the founder of his race, formed wholly in his own likeness, live for ever.

5. The illustrious Rája BHOJA DEVA, formerly reigned : he was the chief of the Paramár princes, and in glory equal to the conqueror of KANSA. He traversed the earth in victory even to its ocean limits.

6. On the appearance of this glorious king, the fame of all hostile princes in all regions of the earth faded into obscurity, as white water-lilies in a ruffled lake bowing their heads submissively, lose their brightness before the world-pervading glories of the rising full moon.

7. To Rája BHOJA succeeded UDAYÁDITYA, whose constant delight was in the pursuit of pleasure : he was singularly endowed with the virtues of a hero ; and stripped his enemies of their glory and fame.

8. How many proud princes with their terrible armies did not this Rája overthrow in ever-memorable battles, which resembled the war of elements in the universal deluge by the rapid discharge of his irresistible and fast-flying arrows ; or he was like the whirlwind, which rising up at the universal deluge by its irresistible force, overthrows whole ranges of terrific and inaccessible mountains.

9. After him succeeded Rája NARAVARMA, who smote his enemies to death. He was wise and steadfast in support of religion and virtue : a very paragon of excellence, and a perfect model to the princes of the earth.

10. He restored to religion, who stood infirmly on one foot in this iron age of guilt, its four-fold support, by making daily grants of land to Brahmans.

11. YASHOVARMA, the chief ornament of the Cshatriya tribe, succeeded to him : and to him succeeded AJAYAVARMA, distinguished by his wealth and victories.

12. His son VINDHAYAVARMA, glorious in his life, next followed. He was distinguished for his heroism, and by his personal prowess, and directed his ambition to the reduction of the country of Guzerát.

13. The sword of this warrior assumed a threefold edge, when up-raised to yield protection to the three worlds.

14. His son AMUSHYAYANA, equal to Indra in glory, next ruled the people. SUBHATAVARMA, whose aim was directed towards confirming the people in the practice of virtue, succeeded to him.

15. The angered prowess of this conqueror, like the fiery rays of the sun, which exercised its thundering rage on the city of *Patan* in (or cities of) *Guzerát*, is witnessed to the present day in the forest-conflagrations that still prevail in the country.

16. On the ascent of this prince to heaven, his son, ARJUNA Rája, succeeded, who still holds on his arms the circle of this earth, as a bracelet encircles the wrists.

17. This prince, when still a child, put JAYA SINHA Rája to flight even in child's play ; the eight Dikpáls (or rulers of the eight corners of the world) smiled at his success. Thus his fame reached the ends of the world.

18. He is a very treasure of poetry and melody. SĀRASWATI, delighted by the accomplishments of this prince, gave him her own lyre and her sacred volumes.

19. To whom but to him, who is equally renowned for the three-fold virtues, learning, valour, and generosity, can we attribute the enlightenment of the three worlds ?

To this Rája belongs all prosperity. By these presents he informs the officers of Government, all Brahmans and others, the patèl and rayats of the village of Piriwiri in the Shakapur parganá, that in the fort of Mandu, this day 10th Phálgun Shakla of the Samvat year 1267, he has given away this village in free gift, in commemoration of his accession, after the prescribed ablutions and due worship of SAMBHU, and with due regard to the fleeting vanities of this world.

20th verse. As the clouds are drifted along by the wind, so enjoyment from the senses lasts but for an instant : the life of man is like the dew-drop depending from the tip of a blade of grass ; and virtue is the only friend that will avail in the world to come.

Thus reflecting upon the vanities of this world, he resolved to seek the (sure though) invisible rewards of a future state. He therefore gave this village to the Brahman GOVINDA, his purohit, the son of JAITRAH SINH, the son of SOMADEVA, the son of DELANA AVASAVIKA, of the Tribe (Prawar) of KÁSHYAPA, VATSÁRA and NAIDHRUVA, of the family (*Gotra*) of KÁSHYAPA, and a follower of the Madhyandina (or Wajasaneya) *shakha* or branch of the *vèdas*. He gave the whole village to its utmost limits, and all its groves of trees, with the full usufruct of its rents and revenues and rights, and of all the moveable property therein, including all right to trove property found therein, that he and his father and mother may increase in good works and in reputation. This gift is to last so long as the moon, and sun, and the earth shall endure, being duly made with consecrated water on a befitting record and with all reverence. Let the patèl and all the inhabitants of this village, bearing the royal generosity in mind, obey his orders, and make over to him the full usufruct of all the rights and dues heretofore paid to Government, excepting only such endowments and grants as have been made to temples and Brahmins. And let my descendants, and all who may succeed me, though not of my blood, well understanding that they will thereby be entitled to a participation in the fruits, preserve and maintain this grant in its integrity.

It has been written,—

“SAGAR and many other princes have enjoyed the earth in succession. But every prince who maintains in full force any grant of a predecessor, acquires the same religious merit and title to future reward as the original donor.”

And again it has been said,—

“The Rájá, who resumes grants of land made as a religious offering either by himself or by former Rájás, shall become a vile worm to roll in filthy ordure: and shall drag his ancestors down into the same pollution. Reflecting that power and wealth and even life itself, are as unstable as the drop that floats on the leaf of the lotus, let every man refrain from detracting from the good name and from perverting the religious merits of another.”

Written on Thursday, 10th Phálgun, Shudha of the Samvat year 1267, by the Ráj-Gúru MADANA, and with the concurrence of the most learned Pandit BILHANA.

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II.—*Note on the white satin embroidered Scarfs of the Tibetan Priests.*  
*By Major T. H. A. LLOYD. With a translation of the motto on the*  
*margin of one presented to the Asiatic Society. By ALEX. CSOMA*  
*KÖRÖSI.*

Having received lately, with a letter from Bútan, one of the silk scarfs mentioned by TURNER as in use in that country and Tibet, which, though rather dirty, is of a superior manufacture and more highly ornamented with figures of deities than those I have heretofore met with, I think it may be presented as a specimen to the Society. I can fully confirm TURNER's account of its general use in all intercourse, and am sorry I have not had any opportunity of ascertaining the origin of the custom, which is, I believe, peculiar to Tibet, Bútan, and Sikhim. I applied to Mr. CSOMA KÖRÖSI for an explanation of the sentences woven in at the ends of the scarf, and that gentleman has kindly transcribed and translated them. I enclose his notes on the subject, and to save you the trouble of a reference, I shall copy what TURNER says on this subject; to whose account I can only add that these scarfs are almost indispensable in all religious offerings, as well as on the occasions he mentions.

*Titulya, 31st May, 1836.*

T. H. A. LLOYD.

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*Extract from Turner's Embassy, 4to. Edition, 1800.*

Page 67. "We each advanced, presenting, one after the other, a white silk scarf, or long narrow piece of *pelong*, fringed at both ends, as is the custom in these countries, to the Rája, who, keeping his seat all the time, took them in his hand, and passed them to his *zempi*."

Page 71. We delivered to the *zempi*, or master of the ceremonies, a silk scarf for each of us, which being thrown across our shoulders, he dismissed us.

Page 72. An inferior, on approaching a superior, presents the white silk scarf; and, when dismissed, has one thrown over his neck, with the ends hanging down in front. Equals exchange scarfs on meeting, bending towards each other, with an inclination of the body. No intercourse whatever takes place without the intervention of a scarf; it always accompanies every letter, being enclosed in the same packet, however distant the place to which it is dispatched. Two colours are in use for this manufacture, which is of China, white and red: the latter is rather confined to the lower orders: the white is respectful in proportion to its purity and fineness; there are various degrees in both. I am yet ignorant of the origin of this custom, but shall endeavour, at some future time, to obtain an explanation of it.

P. S.—I may also mention that the *kow-tow* or nine prostrations, as knocking the head nine times on the ground, is in these countries always performed by inferiors approaching their superiors.”

*Translation of a Tibetan sloka, found on a white piece of China scarf, called བཟ་མིས་ཁ་བདགས་: b,krashis kha b,tags, or “scarf of benediction.”*

ཨ ། ཁིན་མེ་བདེ་ལེགས་ མཚན་བདེ་ལེགས་ ། ཁིན་མའི་ཐུང་ཡང་བདེ་  
ལེགས་ཤིང་ །

ཁིན་མཚན་རྩལ་ཐུ་བདེ་ལེགས་པའི་ ། དཀོན་ཙམ་གཟུམ་ཁྱི་གཟ་མིས་ཤོག

*The same in Roman Character.*

Nyin-mo bde-legs mts'han bde'-legs, Nyin-mahi gung yang bde-legs-shing,

Nyin mts'han rtag-tu brda-legs-pahi, dkon-chog gsum-gyi bkra-shis shog.

*Translation.*

“Blessed the day ; blessed the night ; the mid-day also being blessed : may day and night, always return (bring) the special favour of the three most precious (holy) ones.”

(Or thus ; the favour of the eminent three holy ones) the བདེ་ལེགས་པ་ being rendered, in Latin, *insignis, eminens*, &c.

NOTE.—On the cloth the བདེ་ལེགས་ is not sufficiently distinct ; I took it first for བདེ་ལེགས་ as in the two former lines ; but now I correct it as it probably stands on the cloth.

30th May.

A. CSOMA KÖRÖSI.

### III.—Note on the origin of the Armenian Era, and the reformation of the Haican Kalendar. By JOHANNES AYDALL, Esq., M. A. S.

While the Abyssinians, Babylonians, Egyptians, Persians, Bactrians, and other primitive nations of Asia, have each had their respective epochs, the people of Armenia, where the descendants of the second grand progenitor of mankind began to increase and multiply, are not without a national era of their own. It is not my intention to enter here into a description of the various eras that have from ancient times obtained among the people of the East, as they have been successfully treated of in the chronological works of learned authors. I shall only confine my observations to the origin of the Armenian era, and the reformation of the Haican or Armenian kalendar.

It appears from our historical records that the Armenian era originated in A. M. 3252, immediately after the coronation of the Armenian king PAROYR. ARBACES, prince of the Medes, it must be remembered, having availed himself of the assistance of PAROYR, and of BELESIS NABONASSAR, a prince of Babylon, succeeded in subverting the Assyrian kingdom, and proclaiming himself king of Assyria. Ensigns of royalty were conferred by the conqueror on both of his powerful allies, each of whom returned from the field of battle to his respective country. This memorable conquest of Assyria was signalled by the commencement of the era of NABONASSAR in Babylon, and by the origin of the Haican era in Armenia, which dates 743 years before Christ.

The Armenian era was from the commencement regulated according to solar years, like the eras of the Babylonians, Medes, Persians, and Egyptians. The ancients were of opinion that the solar year consisted of 365 days, without paying any regard to the addition of the six hours, which formed the concluding part of each year. Consequently, the Armenian era, like that of YEZDEGIRD the third of Persia, anticipated the Julian year by one day in every four years. They divided the year into twelve months, giving to each 30 days, and added five days at the end, called Աւելաց *Aveliaz*, which signifies *added*, and is equivalent to the Greek word *pagomen* (παγομεν.) Thus the Armenian calendar year was made to comprise 365 days, leaving out the six hours. And according to this mode of computation all the Armenian years are *common*, but not *intercalary*. The following are the names and days of the Armenian months.

*Armenian months. Days of the mths. Total of the days.*

Նավասարդ . Navasard,	30	30
Հորի ... Hori, . . .	30	60
Սահմի .. Sahmi, ..	30	90
Տրեյ ... Trey, . . .	30	120
Գաղոց ... Kaghoz, .	30	150
Արաց ... Araz, ..	30	180
Մեհեկան . Mehekan,	30	210
Արեգ ... Areg, ..	30	240
Ահեկան . Ahekan, .	30	270
Մարտի . Marery, .	30	300
Մարգազ . Margaz, .	30	330
Հիւրոտից . . Hirotiz, ..	30	360
Աւելաց Aveliaz, ..	5	365

Here in the order of the Armenian months are to be seen not only the number of days thereof, commencing from Navasard, which is the first month of the year according to the Armenian era, but also the total of the days of the year up to *Aveliaz* or *Pagomen*, which invariably consists of 5 days, even in leap years.

According to the above mode of computation, the month of Navasard will commence on the 24th of August in the year 1836, and after a lapse of four years it will begin on the 23rd of August 1840.

In this manner it will anticipate the Julian year by one day in every four years, and after a period of 120 years the difference between the Armenian and Julian epochs will be 30 days. The lapse of 1460 years will increase this difference to a whole year, and the beginning of Navasard will again fall on the 24th of August, the day on which it will have commenced in the year 1836.

It is stated in ancient Armenian chronological works, that the Armenian era was recommenced on the 11th of July, A. D. 552, on which day fell the first of Navasard. But the want of an intercalary day in the Armenian year creates a deviation of the beginning of the month of Navasard from the day of the Roman month, on which it originally commenced. We know on the authority of Armenian authors, that the month of Areg in the early part of the fifth century corresponded with the month of March. NIERSES the Graceful concludes his letter to the Greek Emperor EMMANUEL thus: "Written in the Armenian era 619, in the Armenian month of Areg, and in the Roman month of October." And in an old manuscript copy of the Armenian Ritual is stated thus: "Written in the Armenian era 670, in the month of Mehekan, which corresponds with the month of August."

In the year of Christ 551 the Armenian Kalendar was reformed by the Armenian Pontiff, MOSES the Second, a native of the village of Eliward, in the province of Aragazotn, and eminently distinguished for his extraordinary talents and profound erudition. On his elevation to the pontifical throne, he devoted his attention to the reformation of the Armenian Kalendar. A council was accordingly convened by him in Duin, consisting of learned Bishops and scientific individuals, by whose co-operation he succeeded in remodelling the Armenian Kalendar, as much as the circumstances of the times permitted, by newly commencing the cycle. Thenceforward the Armenian nation adopted the reformed Kalendar, and generally began to reckon their years in accordance with the rule laid down therein. In order to know the Armenian era, deduct from the Christian era 551 years, and the remainder, whatever it may be, will be the Armenian era required. For instance, if 551 years be deducted from 1836, the remainder will be 1285, which is the present Armenian year.

It is usual with the people of Armenia to reckon the hours of the day from sunset to sunset, in imitation of the custom prevalent in ancient times amongst the Italians. The day, consisting of 24 hours, is called in Armenian Աւր *Aur*, which entirely corresponds in sound with the English word *hour*! In the Armenian language the hours of the day and night have respectively distinct names, which I shall state below.

## Names of the hours of the Day.

1. Այդ: Aig,
2. Ճայդ: Zaig,
3. Զայրացեալ: Zairazial,
4. Ճառաքայթեալ: Charagathail,
5. Շառաւիղեալ: Sharavighail,
6. Երկրաօրէս: Erkrates,
7. Շանթակող: Shanthakogh,
8. Հրակաթ: Hirakath,
9. Հոսր փայլեալ: Húr Phailail,
10. Թաղաթեալ: Thaghathail,
11. Առաղօտ: Araghot,
12. Արփող: Arphogh.

## Names of the hours of the Night.

1. Խաւարակ: Khavarak,
2. Աղջաճողջ: Aghjamúghj,
3. Մթացեալ: Mithazail,
4. Շաղաւօտ: Shaghavot,
5. Կամաւօտ: Kamavot,
6. Բաւական: Bavakan,
7. Խօթափեալ: Khothapail,
8. Գիզակ: Gizak,
9. Լուսաճեճ: Lusachiem,
10. Առաւօտ: Aravot,
11. Լուսափայլ: Lusapail,
12. Փայլածու: Phailazú.

It is recorded in the ancient annals of Armenia, that ARMENAC, the son of HAIC, had twelve brothers, who were respectively called by the names of the twelve Armenian months. He had also twenty-four sisters, who received the respective names of the twenty-four hours of the day.

The Armenians of British India as well as of other parts of the globe, have adopted the use of the old Julian style and months in mercantile transactions, and in their correspondence with Europeans.

IV.—*Conjectures on the march of Alexander.* By M. COURT, ancien élève de l'école militaire de St. Cyr.

[Communicated by Captain C. M. WADE\*.]

According to PLUTARCH, the first country through which ALEXANDER passed on leaving Hyrcania, was Parthia. I shall therefore set out from this province, which is supposed to be the modern *Khorasán*; and what confirms us in this supposition is, that to the south of Parthia was situated Tabiana, now *Thabas*, which town is to be found in this direction between two deserts. Another incontestable proof is, that the province of Margiana, which was contiguous to Parthia, is to be found situated in the country of *Meimané*, watered by the modern *Murg-áb*, called Margus by the ancients.

BARBIE' DU BOCAGE fixes the capital of the Parthian empire at Nicephorium, or *Nishapúr*. But I must here notice that the town of *Tún* may very probably be Parthonisa, of which he makes mention; and if this be the case, the tombs which are here to be found are those of the kings of Parthia.

\* We are indebted to the kindness of a lady friend for the translation of M. COURT's valuable Memoir.—ED.

It was in this province that the traitor BESSUS seized the person of DARIUS, whom he subsequently assassinated. History does not record the spot where the assassination took place. From the statement of PLUTARCH, it appears ALEXANDER sojourned for some time in Parthia. After he left this province his march became exceedingly irregular and confused, and we find no historical elucidation of it. Some historians say that he returned to Hyrcania; PLUTARCH is amongst those who give us this statement; others, however, relate that he marched into Bactriana. RENNEL, the geographer, is of opinion, that on leaving the western provinces of the Caspian Sea he passed through *Aria* and *Zarangæi* to make the conquest of *Arachosia*, and that from thence he proceeded to direct his attack upon the Bactrians. I am led to be of this opinion; and what most strongly induces me to adopt it, is the death of PHILOTAS, which was very much anterior to the murder of CLITUS; and it is well known that the former perished in *Zarangæi*, and the latter in *Sogdiana*. ALEXANDER on leaving Parthia passed through *Aria*, which is watered by the modern *Arius*, anciently called the *Heriroud*, and which passed by *Herat*. He here built a town, which I imagine must be that called *Obeh*, situated ten farsangs to the east of *Herat*: however, this latter town was built by ALEXANDER, according to the reports of its inhabitants; but some geographers refute their statement by giving as their opinion, that *Herat* is not the *Aria* of the ancients. BARBIE' DU BOCAGE says, that *Artacvana*, otherwise called *Aria*, was the capital of the province of this name. In regard to this, I must notice that in my travels from *Ispahán* to *Yezd*, I found the town of *Ardecon*, in its vicinity, in the same route, the equally ancient town of *Akda*, and quite close to this again was another called *Beni-bít*. Now these three towns bear in their names the strongest resemblance to those called *Aria*, *Artacvana*, and *Bitaxia*, that BARBIE OF BOCAGE fixes in *Aria Proper*. This country, of which I have just spoken, is situated between *Ardistán* and the province of *Yezd*, and is no other than the *Isatæchæ* (Ἰσατοῖχαι) of the Greeks, where the worship of fire and the institutions of the Magi were established. I must, moreover, notice that at the distance of two days' journey southward of the town of *Tún*, we enter the territory of *Bucharia*, and here meet with ruins, which may be attributed to the ancient Persians; but I must observe, that neither in this canton or in those of the three above-mentioned towns, is any river bearing the name of *Arius* to be found.

From *Areia*, ALEXANDER marched into *Zarangæi*, now called *Sigistan*, but a vestige of its ancient name remains in that of the actual capital called *Zarang*, which is no other than the town of *Propthasia*, where ALEXANDER put PHILOTAS to death.

This town was situated at a short distance from the *Etymander*, now called the *Hind-mind*, which river empties itself into the lake *Zéré*, otherwise called *Néibendam*, known by the ancients under the name of the lake Arian. This river receives in its course that which flows from the territory of *Farrah*, and which is no other than the *Pharmacotis* of the Greeks, for there is not a doubt that *Farrah* was the ancient *Phra*, the country of the famous *RUSTAM* of Persia.

From thence he went into *Arachosia*, a province watered by the river *Arachotus*, which emptied itself into the lake *Areiana*, and which is the same as the *Aracandab*, which has its source in the canton of *Navor*, and which subsequently flows through the territory of *Candahar*, and from thence falls into the *Hind-mind* four farsangs below *Gerishk*. The town which was situated on this river, said to be built by *SEMIAMIS*, ought to be found amongst the ruins of *Candahar*, or more probably it is the ruins of that town which are visible upon the river *Arcassan*, four farsangs below *Candahar* upon the road to *Shikárpur*. Two equally ancient towns are those of *Eskarganj*, and of *Sher-safa*, the ruins of which may be seen upon the road which leads to *Ghazní*. As to the *Alexandropolis* of *Arrokhaje*, it undoubtedly is old *Candahar*. *Nicæa* appears to me to be *Ghazní*.

The Macedonian conqueror must necessarily have passed through *Candahar*, as the several roads branch off from this town which lead to India, through *Cábúl*, *Ghazní* and *Shikárpur*; and moreover all the extent of country to the south of *Arachosia*, is nothing but one desert of moving sands, which occupy a distance of forty farsangs, stretching over as far as the country of *Neskhí* and *Karan*, which form a part of *Balúchistan*.

To the north of *Arachosia* we find the country of the *Paropamisæi*, separated from *Bactriana*, by a high chain of mountains, to which the name of *Caucasus* was given by the companions of *ALEXANDER*, out of compliment to this prince, who wished to traverse them. Here they found a cavern that they transformed into the cave of *Prometheus*. I have been assured that a similar cavern does exist in the environs of *Candahar*, at the spot called *Khar-Jemshid-jan*. The mountainous part of the country of *Paropamisæi* is now inhabited by *Hazarés*, amongst whom exist a tribe of the *Bactiaris*, who doubtless are a descent from the intrepid *Bactrians* who offered such a valorous resistance to *ALEXANDER*, and who repulsed him several times before they were made to surrender. I presume that this conqueror penetrated into this country, either by re-ascending the valley watered by the *Aracand-ab*, or by passing through the defiles of the chain of *Gul-kau*, near *Ghazní*, where we may remark some dykes built here by

Sultan MAHMUD GHAZNAVÍ. In this passage he had to penetrate through heavy falls of snow before he could reach Bactria, the capital of Bactriana, which they say must have been the same as *Bulkh*.

This country, according to BARBIE' DU BOGAGE, extended to the south of the Oxus, a large river which stretched as far as the Paropamisus. It comprises Bactriana, properly so called, and the country of Margiana, of which I have already spoken.

OXYARTES, the father of ROXANA, was king of the whole of this country.

It was at Bactria that ALEXANDER condemned BESSUS to have his nose and ears mutilated. CALISTHENES was arrested at the place called Cariata. PLUTARCH relates, that ALEXANDER was on the banks or confines of the Oxus when he first meditated the conquest of India.

The route which he pursued is, I imagine, the one now adopted by the caravans which pass from *Bulkh* to *Cábul*, and which appears to be the only passable road through which this mountainous country can be traversed.

This road passes through the territory of *Bamiana*, a very ancient town, not far from which are to be found the prodigious ruins named *Gulgula*. Six kos further, we meet with others that are attributed to ZOHAK SHAH; and at the place called *Siggan*, there are the remains of a fortress, the building of which the inhabitants attribute to ALEXANDER. If this tradition be well founded, there is not a doubt that it must have been in this spot that ALEXANDER built the town in the country of the Paropamisæi, and from whence he proceeded to Cophenes.

This starting point is a stumbling-stone for geographers, inasmuch as none of them have been able to determine its exact position. For, proceeding in their narration from thence, some state that he marched to *Cow*, which they mistake for Cophenes; and had he done so, he must have quitted the Paropamisæi, gone through the defiles of *Ghazní*, and have precipitated himself from thence to the cantons of *Gerdiz* and *Lougird*; then crossing the country of the *Bangishs* he would have proceeded to Peucelaotis by the route of *Kohát*. In this case *Borikrajan* must be Arigæum, of which we find mention made in history. But I would observe, that along this route no such important river as the Cophenes is to be found; and then again how improbable it appears that ALEXANDER, who had such an immense tract of land to explore, would have ordered his generals HEPHÆSTION and PERDICCAS to conduct a division through a track so distant as that through Peucelaotis. It is then more probable that he must have taken the road to *Cábul*, and from thence dismissed his generals, with orders to proceed in their route to *Jelilábad*,

and he himself pursued that which led to *Lagman*, and which answers the historical description, being very rugged and mountainous, but still such as to allow the cavalry to penetrate through it. From thence he could give assistance to that division of his army which were detached towards *Peucelaotis*.

Whilst pursuing this train of supposition, I cannot help observing that the Macedonian conqueror must of necessity have passed through *Cábul*; for its geographical position is so brilliant, so advantageous, that it is a military position which we cannot but suppose that he noticed, and therefore traversed it.

It is then only the more unaccountable, that to this day that no geographer has been able to ascertain the ancient name of this town, the foundation of which the inhabitants attribute to *KEIKOBAD*. From the fertility and luxuriance of this territory, I am led to think that it must be the same as *Cabura* or *Ortospanum*, of which *BARBIE' DU BOCAGE* speaks, describing it as "a town situated upon the route which led from the Alexandria of the *Areians* to India, and which was not very far from the *Paropamisan Alexandria*."

*RENNEL'S* opinion appears to be erroneous when he says, that the *Cow-mul* of *BABER SHAH* is the same as the *Cophenes*, the principal branches of which, he adds, are rivers flowing from the *Ghazni* and *Guerdiz*; for the river *Ghazni*, according to the account given by its neighbouring inhabitants, empties itself into a lake which is situated at the south of *Moukkor*, in the canton of *Zernele*. As to the branch called the *Guerdiz*, it is no other than a narrow stream, and can scarcely be denominated a river. On the other hand, he adds, that the river of *Cophenes* was defined as the eastern boundary of the province of *Paropamisus*, of which *Alexandria* was the capital. I must observe, that from the direction the *Cow* takes in its course, it goes too far southward of the *Paropamisus* to form its eastern boundary; what he says there seems to have a more just reference to the province of *Arachosia*.

I am very tenacious, then, of my opinion, that the *Cophenes* must be the same as the river of *Cábul*. This river has its source in the country of the *Hazarés*, betwixt *Bamian* and *Cábul*; it has its fall in the mountains of *Meidan*, through which runs the road which leads from *Cábul* to *Balkh*; from thence it traverses *Cábul*, and receives below this town the river of *Shéikabad*, which also takes its source from the *Hazarés*; a little lower still it is enlarged by its junction with the *Panje-shir*; this takes place at the spot called *Teng-carun*. From thence it proceeds in its course through a mountainous part of the country, and empties itself in the western extremity of the valley

of *Lagman*, where it receives the waters of the *Alumkhur*, which flow downwards from that territory. We follow it from thence into the valley of *Jelálábad*, where it is enlarged by its junction with the *Surkh-áb*, which rises in *Peivar*; and then again it receives the *Khonár*, which flows through *Kaféristán*. In leaving this deep valley it passes anew through the mountains of *Dekha*, and empties itself at *Micheni* in the province of *Pesháwar*; and when passing a short distance from *Ashnagar*, it receives below that town the *Jind*, which flows from the country of *Baqor*, then passes by *Nouchareh*, *Akhora* and *Jengir*, and from thence finally empties itself into the Indus; and here we lose it about half a league below the fortress of *Attok*\*. From *Cábul* to *Jelálábad* it is known by the name of the river *Cábul*, in the *Moumends* by that of *Khameh*, at *Pisháwar* they give it the name of *Nagoumun*, and below that it is called *Landeh*, by the *Kuttuks* and *Yusufzies*.

From its source to *Ashnagar* it abounds in rapids, which make it quite unnavigable in the rainy season, and more particularly so during the heavy falls of snow, which swell it out to a prodigious breadth. I have above concluded that ALEXANDER took the route to *Lagman*, after having ordered his generals to go to *Pencelaotis*.

The *Aspii* and the *Thyræi* that he attacked, appear to me to be the *Buzbins* and the *Touris*, who inhabit the mountainous part of the country which separates the valleys of *Lagman* and of *Jelálábad* from the territory of *Cábul*. As to the town of *Arigæum*, which was found beyond these mountains, it may be *Alichung*, a very ancient town situated in the valley of *Lagman*. That of *Tigueri*, which is here to be observed near the rivers of *Meitarlam*, is also of a very ancient date. The two rivers of *Choe* and of *Evaspla*, that he must have crossed in order to arrive, must in all probability be the *Penj-shir* and *Alumkhar*.

The valley of *Lagman*, as also that of *Jelálábad*, were formerly inhabited by an idolatrous people, who were driven after the first conquests of the Mahomedans beyond the chain of *Hindu-kou*, the *Emodus* of the ancients. They are now known under the names *Siáposh* or *Kaferis*, and the country that they inhabit is just below that of *Kaferistán*.

\* The latter part of its course may be traced on a map, which we have been permitted to copy from M. COURT's original survey on its way to the Asiatic Society of Paris, and which, with a few extracts from his geographical notes on the country, will appear in our next number.—ED.

These nations declare that they are descendants of the *Ghoris*, which name resembles greatly that of *Guræi*, of which notice is taken in history.

At *Jelálábád* ruins of a considerable extent are to be found: their origin is not, however, known. It is the same with those that may be observed three stages further off, near the defile of the *Kheibers*, and which are called *Pishboulak*. These last are situated on the northern range of the chain of *Sefidkoh*, and not far from thence is the village of *Azarno*, which one meets in the road from *Jelálábád* to *Pesháwar*. In these ruins are to be found some medals exactly like those of *Manikyála*; and from this I am led to believe that these towns must be of equal antiquity. It remains now to discover what were the names by which they were then called. The *Muminds* appear now to occupy the country of the *Assaceni*, against whom ALEXANDER marched, after having crossed the *Guræus*. This river, which he crossed with great difficulty, appears to me to be the *Khonar*, a river the stream of which is very rapid and full of polished stones, like the *Alumkhar*: it flows from *Kaféristan*. If it be not this river, it must be that of *Cábul* itself, which here took the name of *Guræus*, from the *Ghoræus* which inhabited the banks, or rather the *Jinde* which traverses the country of *Bajru*.

From thence ALEXANDER went into the country of *Bajru*, called by us *Bijore*. This town is situated 60 kos N. N. W. of *Pesháwar*: is very ancient, and we may there find many medals like those of *Manikyála*. It remains to be proved if it is really there that we find the *Bazira* of the Greeks. This mountainous country is traversed by the river *Jinde*, which divides it from the canton of *Suwát*, and which after having emptied itself into the defiles of the *Tengui* passes to the west of *Ashnagar*, throwing itself from thence into that of *Cábul*. If *Bajor* be the *Bazira* of the Greeks, it is in this country that we must search for the famous mountain of *Aornus*, the seizure of which was one of ALEXANDER'S most brilliant exploits.

From this country ALEXANDER passed towards the *Indus*, and took possession of the town and fortress of *Peucelaotis*, which *HEPHÆSTION* and *PERDICCAS* had been besieging for upwards of a month.

Several geographers think that this province is the same as that of *Pesháwar*. In this case the *Malamantus*, upon which *Peucela* was built, is no other than the river *Barreh*, which flows downwards from the *Kheiber* mountains, and which loses itself in that of *Cábul*. *RENNÉL*, led into error by *FORSTER*, supposes that *Pakkheri*, which he calls *Pukkholi*, was the *Peucelaotis* of the Greeks. This last town was found at the west of the *Indus*, whilst *Pakkheri* was at the east of

this stream, and at a considerable distance from it, and moreover in a mountainous country, where the Indus has never been able to change its course. Besides, Peucelaotis was contiguous to Bazira, a town that they suppose must have been *Bajúr*.

From Peucelaotis Alexander returned on his steps, directing his march towards the north-west, in order to investigate Aornus. After the capture of this rock, he made a second expedition into the country of the Assaceni, between Bazira and Peucelaotis.

*Ashnagar*, which several geographers mistake for Massaga, the capital of the Assaceni, appears to me to be the town of Nysa. Its vicinity to Cophenes, and above all what PLUTARCH states that ALEXANDER said to the Macedonians, who hesitated and seemed to fear encountering so deep a river, all corroborate my conjecture. I must, besides, observe, that three *kos* below this town, and on the borders of the *Cábul*, is the village of *Nysetta*, where there are some vestiges to be found. All the suburbs of *Ashnagar* are scattered over with vast ruins, of none of which we know the origin, and where we find some very ancient medals. The actual fortress of *Ashnagar* overlooks this territory.

In starting from thence to the Indus we meet no other river, with the exception of a small stream which flows from the *Babúzies*, and which passes between the *Hotti* and the *Kapourdigarhi* to throw itself from thence into the river *Cábul*, below the *Nouchareh*.

At six *kos* to the N. E. of *Ashnagar* is the mountain of *Behhi*, isolated upon a vast plain, and upon which may be remarked the ruins of a very vast town, which seems to be of most ancient date, and which, according to the reports of its present inhabitants, was the residence of the ancient kings of that country. Specimens of bas reliefs may there be found; also the remains of an aqueduct, by which thence the waters of *Ashnagar* were carried to the town. At eight *kos* to the north of *Behhi* we see the summit of a mountain, situated between the canton of the *Babúzies* and the massive ruins of a fortress, which was only accessible by a path cut through the rock.

This spot is called *Pelley*. At 18 *kos* N. E. of *Ashnagar* we see on the southern range of the mountain called *Kohganga* the vast ruins of a town, that the present inhabitants say was peopled by idolaters, and which is quite close to the existing town *Bazar*. At 15 *kos* to the east of *Ashnagar* is the actual town of *Kapourdigarhi*, which from its locality might well be the ancient Caspatyrus, the capital of the Gandarii, which is placed by our geographers to the east of Assaceni, on the western bank of the river Indus.

I have remarked, that close to this town is an inscription in characters quite similar to those we observe on the ancient Indian medals

of *Manikyala*\*. To the west of this town is the territory of *Hotti* or *Hoddi*, which received its name from an ancient sovereign of this country, who might have been the *OMPHIS* who surrendered himself to *ALEXANDER*.

On the western bank of the Indus ruins may be observed at *Pevur Toppi*, *Hound*, and *Mahamadpur*. Those of *Hound* are all striking, and there may be found blocks of marble containing inscriptions traced in characters quite unknown to the inhabitants.

As for the ruins of *Mahamadpur*, situated at the junction of the Indus and the river *Cibul*, they are, we are told, more than two thousand years of age. After having exhausted the above facts relative to the country of the *Youzoufzies*, I shall be led to form more than one conjecture on the true position of *Bazira*; but I have been quite perplexed by *RENNEL*, who says that “*ALEXANDER* after his arrival at the bridge made an inland excursion into the country situated on the western banks of the Indus, to visit the town of *Nysa*, and that he subsequently penetrated into the country situated between the two rivers of *Cophenes* and *Indus*.”

Being quite devoid of all references or means of solving my doubts, I am obliged to adopt the supposition of this judicious guide.

As to the *Assaceni* who inhabit the lower part of the western bank of the Indus, they are only inhabitants of *Katteuk*, and the town of *Ora* is perhaps the same as *Akhora*. As to that of *Sabissa* or *Capissa*, we must seek for it in the canton of *Lachittiri*, or in that of *Kohat*.

As relates to *Aornus*, which is situated in this country, and of which *ALEXANDER* made himself master, it is probably the castle which was opposite *Attok*, and the vestiges of which we see upon the summit of the mountain: its foundation is attributed to *Raja-Hoddi*. According to some geographers, *Attok* is the town of *Taxila*; through which the army of *ALEXANDER* effected the passage of the Indus. If it be not this town, we must recognize it in that of *Torbila*: the locality of the ruins which we there remark lead me to form this conjecture. It is possible besides, that this name may have undergone some change in its orthography. We know that the Greeks were not exact in their mode of spelling the names of the towns and countries which they invaded.

\* We have written to *M. COURT* to request, if it be possible, that facsimiles may be procured, both of the inscription near *Ashnagar*, and of those on the marble blocks at *Hound*. The Pehlevi inscription copied by *M. COURT* from one of the *Manikyala* topes has excited very great interest at Paris: it would be very desirable to obtain a precise facsimile of it.—ED.

V.—*Experimental Researches on the Depressions of the Wet-bulb Hygrometer.* By JAMES PRINSEP, F. R. S. Sec. As. Soc.

At the first meeting of the British Association for the advancement of Science, the Committee appointed to draw up a list of desiderata in the various departments of science, included among the objects of meteorological inquiry an investigation of the theory of the wet-bulb hygrometer: and in the circular then prepared, and at the subsequent annual meetings repeated, the Meteorological Committee was pleased to compliment with its favourable notice the papers published anonymously on this subject in the Calcutta "*Gleanings in Science.*"

The requisition of the British Association appears to have remained unanswered until the Dublin meeting in August last, when Professor APJOHN, of the Royal College of Surgeons in Dublin, brought forward the results of his own experiments, and expounded a simple and elegant formula which he had in every case found to agree with them, and to be practically applicable to the various conditions of the problem.

Dr. APJOHN's papers are published in the Philosophical Magazine for March, October and December, 1835; and it is principally an observation in the opening of his memoir which induces me to revert to the subject. "In the first report," he says, "mention is made of a register of observations kept in the East Indies, which, as belonging to high temperatures, would necessarily exhibit great depressions, and would therefore be valuable as a standard of comparison; but I have in vain searched for the Calcutta Journal '*Gleanings in Science,*' in which they are said to be contained."

In one respect we may deem it fortunate that the sluggish circulation of our humble periodical had not attained the shores of Ireland; if to the want of the data which "the *Gleanings*" might have furnished we are indebted for the series of experiments undertaken by Dr. APJOHN; for the more varied these may be, and the more numerous the observers, the more confidence may reasonably be placed in any formula that may accommodate itself to the whole.

I might without vanity claim to my own share as large a portion of the labour of experimental investigation as has rewarded the patience of any observer of the wet-bulb indications; having, with little intermission, registered daily observations since 1822; but I am more anxious to claim for my lamented fellow labourer, Captain HERBERT, the merit of having treated the theoretical portion of the subject—I will not say in a more philosophical manner than had hitherto been followed, because GAY LUSSAC had before exercised his masterly hand upon it, but,—in a manner equally sound in principle and creditable to himself,

considering that he had not the means of referring to the original memoir of the French philosopher, and that he had only the erroneous views of the *Edinburgh Encyclopediast* guide, or rather to misguide, him.

In Captain HERBERT's first paper\*, he reviewed with unsparing criticism the paralogistic reasonings of the Encyclopedist, Mr. ANDERSON, and pointed out the true basis of the wet-bulb depression so nearly in accordance with the views of Dr. APJOHN, of Dr. HUDSON his coadjutor, and of M. GAY LUSAC, that it establishes the general correctness of all, although the particular formula which he proceeded to build upon it, naturally agreed best with the data that my own experiments, published also in the *Gleanings* of March 1829, had furnished to him. He had fortified himself for the investigation by previous study of the doctrine of the latent heat of gaseous bodies, upon which subject he had published a brief but luminous essay in the *Oriental Magazine* for September 1827; and certainly no subject has so much needed a sprinkling of rationality to lay the dust of unphilosophical hypothesis which even yet remains to obscure a plain question; so much so, that Dr. HUDSON, one of our Dublin competitors, while he acknowledges the dependence of the problem on the relative capacity for heat of air and aqueous vapour, "will not dwell on this method nor the corrections it would require, placing no reliance on the truth of the requisite assumptions†."

But before entering into a review of the various theories that have been adopted by others, it may be preferable to describe in as succinct a manner as is consistent with clearness, the course I originally pursued to supply the experimental requisites for calculation, and upon which I ventured to form a table‡ for the reduction of wet-bulb indications to hygrometric degrees in 1828-9§. I have recently concluded a second and even more extended series of similar experiments, with the advantage of superior means and apparatus, which have enabled me to prosecute some branches of the inquiry that I believe have not before engaged sufficient attention.

In all hygrometric speculations it is usual to consider the state of extreme moisture, or the point of aqueous saturation of the air, as

\* *Gleanings*, Vol. I. p. 45.

† *Phil. Mag.* Vol. VII. p. 259.

‡ *Gleanings*, Vol. I. p. 81.

§ Before this period in 1827, I furnished a "table of multipliers" for reducing the depressions into aqueous tensions, calculated from three years meteorological observations at Benares with this instrument and the hair hygrometer. The Royal Society, who did me the unexpected honor to publish my registers, retrenched this table, and the notes which accompanied it. They had been, however, in the mean time printed in the *Calcutta Oriental Magazine* for March, 1827.

represented by  $100^{\circ}$ ; while extreme dryness, or entire absence of aqueous vapour, is expressed by  $0^{\circ}$ . The intervening degrees comprehend every intermediate state of moisture that can possibly occur, and conveniently express the percentage of actual moisture present, or as it is more scientifically termed, the *centesimal* tension of the vapour.

The point of saturation on the wet-bulb instrument (100) is indicated by  $0^{\circ}$ , because evaporation, and the cold consequent on it, then ceases. The questions to be solved then are, 1st, What is the maximum depression, which corresponds to perfect dryness (0) in the assumed scale, for every temperature?—and 2nd, What is the value of each intermediate degree (Fahrenheit) of depression of the wetted thermometer in terms of the *centesimal tension* or 100 hygrometric degrees above alluded to?

I. There is one very easy method of attaining the first object: viz., by exposing a wet-bulb thermometer to a current of perfectly dry air of various temperatures. This was the mode pursued by GAY LUSSAC between the temperatures  $32^{\circ}$  and  $70^{\circ}$ , in 1827: by myself in 1829, between  $70^{\circ}$  and  $140^{\circ}$ , and recently continued up to  $700^{\circ}$  Fahrenheit: it is the plan proposed to be pursued by Dr. HUDSON\*, and employed in the test experiments of Professor ARJOHN in 1835†. In fact, this is the only accurate plan of testing the maximum depression, which is to represent  $0^{\circ}$  on the hygrometric scale: for the exposure of a wet-bulb thermometer in *still air* dried to the utmost, fails to produce a maximum, the instrument being necessarily surrounded with a medium not perfectly dry. Dr. ARJOHN makes the error by this method  $\frac{1}{8}$ th; I have found it about  $\frac{1}{6}$ th.

II. The second question, as to the value of intermediate depressions? may be ascertained by drying the air to various points, as 20, 30, 40 per cent. which can be done by exposing it to various saline liquids, or more conveniently to sulphuric acid of different strength, and then submitting the thermometer to a current of it as before. This mode was used long since by M. GAY LUSSAC in testing the value of the degrees of SAUSSURE's hair hygrometer, and it was followed by myself in a repetition of the same train of experiments in 1825‡. To obtain, however, an equable current of wholly or of partially dried air for a sufficient duration of time, is by no means easy; nor do I think that air merely passed through a tube containing sulphuric acid or chloride of lime, without remaining in protracted contact with it, would be thoroughly deprived of moisture. At any rate, to ensure confidence, there should be the means at hand of record-

\* Phil. Mag. Vol. VII. p. 260.

† Ditto, p. 271.

‡ See BRANDE'S Journal of the Royal Institution, XXII. 28.

ing its actual state. M. GAY LUSSAC merely dried his air by chloride of lime, and his depressions will be seen to be all below the mark.

Professor APJOHN states, that he pressed air from a caoutchouc bag through three of WOLFE's bottles, passing it thrice through the acid on its way to the thermometers. This must have been inconvenient and difficult to regulate, and the knowledge of the real condition of the air was withheld; although there can be little doubt that it was thoroughly dried. My own method was to dry the air previously for days or even weeks in a large gasometer, whence it could be driven in a very uniform current. The secret of the facility I enjoyed in this respect lay in the substitution of *cocoanut oil* for *water* in the reservoirs of my gasometers, which not only prevented the accession of moisture, but preserved the gas unaltered for any length of time;—I have fearlessly lighted a jet of hydrogen that had stood *two years* in my gasometer!

There are other modes of obtaining intermediate stages of dryness: the most obvious is by using the atmosphere itself of a dry or damp day, first ascertaining by DALTON's dewpoint experiment its actual hygrometric state, and noting the corresponding indication of the wet bulb thermometer; the averages of a good meteorological register are of this kind. Again, when damp air is artificially heated by passage through a warm tube, the capacity of the warm air for water being increased while the dew point remains unchanged, an effect tantamount to using drier air may be obtained and exactly estimated. The rarefaction of air also, (in the absence of the means of fresh supply of water) produces a measurable diminution of the ratio of humidity per given volume. These simple methods have been used by all experimenters, particularly by LESLIE himself, the original projector of the evaporation-hygrometer.

In describing, therefore, my experiments directed to the two main inquiries, it will save some circumlocution to designate the methods pursued as, 1st, dry air current; 2nd, current of air having given aqueous tension; 3rd, heated air of known tension; 4th, rarified air do; and 5th, dew-point comparisons.

But there are other important branches of inquiry necessary besides the above two, ere we can hope for a formula to satisfy all conditions of the wet-bulb problem.

III. The experimental effect of diminished and augmented atmospheric pressure?

IV. The amount of depression in other gaseous media? and

V. The effect of greater or less velocity of the air on the temperature of evaporation? This effect has been sufficiently examined by

DALTON himself, as regards the *quantity* of water evaporated. Theoretically, however, it has no influence on its temperature; and this is confirmed by experiment, under certain limitations.

With such an appalling complication of influences to be traced out, it is hardly to be wondered at that M. GAY LUSSAC himself should have given up the prosecution of the wet-bulb problem, or that the Editor of the Royal Institution Journal\* should have joined in its condemnation at a time when the elegant method of DANIELL was winning general favor. Nevertheless, independently of its direct preferability as the most simple mode of registering the humidity of the air, the problem itself is of the highest importance, in the solution not only of very many phenomena in pneumatics and meteorology, but of such standard doctrinal points of theory, as the latent heat of gases and steam; and others of practical utility—as the artificial production of ice and cold. I shall have occasion to adduce a few illustrations ere I conclude; but I must now proceed to my first series of experiments.

§ 1. *On the curve of maximum depression.*

The apparatus used for drying the air is sectionally depicted in Plate XXI. fig. 1, where *a* is a dish containing concentrated sulphuric acid enclosed in a 120 pint gasometer. Another similar dish rests in the glass double bell receiver *b*, wherein are suspended a hair hygrometer (the only instrument applicable as a tell-tale, and indeed an invaluable hygrometer for every purpose) and a delicate thermometer. Through this receiver the air of the gasometer passes to the stopcock and short glass tube *c*, in which is placed a small thermometer, covered with muslin and dipped in distilled water at the moment before the experiment commences.

The only difference in the order of M. GAY LUSSAC's experiments, being, as I have stated above, that he employed chloride of lime *without a tell-tale hygrometer*, while in my first Benares series I employed the same salt *with this addition*, it would be easy to apply to that philosopher's results the correction I found necessary for the want of complete desiccation in my case. At all events, as his series comprehends low temperatures, which were beyond my reach in India, it will render my review of the question more complete to insert his valuable table, converting the centigrade expressions into those of Fahrenheit's thermometer. In the fourth column I have added the aqueous tensions† at the wet-bulb temperature; and in the fifth, the quotients of

\* Jour. Roy. Inst. XV. 296.

† By BIOT's formula founded on DALTON's experiments, and published in the Edinburgh Encyclopedia, Mr. ANDERSON's article *Hygrometry*.

the depressions divided by these tensions, which will be found to be the key to the formation of a *formula* for the problem.

TAB. I.—*Depressions observed by M. Gay Lussac.*

Temp. of dry air <i>t</i> °	Wet-bulb therm. <i>t'</i> °	Depression wet-bulb <i>D</i> °	Aq. tens. at <i>t'</i> <i>f'</i> in	Quot. of <i>D ÷ f'</i>	Temp. of dry air <i>t</i> °	Wet bulb therm. <i>t'</i> °	Depression wet bulb. <i>D</i> °	Aq. tens. at <i>t'</i> <i>f'</i> in	Quot. of <i>D ÷ f'</i>
32.0	22.0	10.0	.139	72	57.2	38.7	18.5	.252	73
33.8	22.8	11.0	.143	76	59.0	39.5	19.5	.260	75
35.6	24.1	11.5	.153	75	60.8	40.6	20.2	.268	75
37.4	25.4	12.0	.157	76	62.6	41.7	20.9	.280	75
39.2	26.9	13.3	.166	74	64.4	42.9	21.5	.292	73
41.0	27.9	13.1	.172	76	66.2	44.0	22.2	.304	74
42.8	29.1	13.7	.179	76	68.0	45.1	22.9	.316	72
44.6	30.2	14.4	.186	72	69.8	45.2	23.6	.317	74
46.4	31.5	14.9	.195	77	71.6	47.3	24.3	.340	71
48.2	32.7	15.5	.204	76	73.4	48.4	25.0	.354	70
50.0	33.9	16.1	.213	75	75.2	49.5	25.7	.363	71
51.8	34.9	16.9	.220	77	77.0	50.5	26.5	.380	70
53.6	36.1	17.5	.231	76					

Average ratio of depression to aq. t., 74

It will be remarked, that with exception of the three or four last experiments, the depression follows a nearly uniform ratio to the aqueous tension, being 74 times greater. The air in the last four was doubtless not quite so dry as in the others; for in my own first series, which begins nearly where the French table leaves off, the depressions are found considerably in excess of M. GAY LUSSAC's results.

In the series in question the presence of the hair hygrometer enables me to make an approximate correction for imperfect dryness founded on a coincidence, which will be explained hereafter, between the curve of depressions and the curve of the hygrometer, so that nine degrees of the latter + or —, for instance, will nearly represent 9 per cent. + or—in the depression, near the dry extremity of the scale\*. The barometric correction will be also explained further on.

TAB. II.—*Maximum Depressions determined at Benares.*

Temp. of dry air <i>t</i>	Wet-bulb Therm. <i>t'</i>	Observed depression. <i>d</i>	Barom. at 32° <i>B</i>	Hair Hygrom. <i>H</i>	Corrected depression. <i>D</i>	Corrected wet bulb <i>t'</i>	Aqueous tens. at <i>t'</i> <i>f'</i> in	Quotient of <i>D ÷ f'</i>
72.5	47.2	25.3	29.43	9.5	27.5	45.0	.315	87
75.0	48.2	26.8	.52	9.5	29.3	45.7	.321	91
78.5	52.1	26.4	.30	9.5	29.3	49.7	.369	78
82.6	54.8	27.8	.26	9.5	30.3	52.3	.403	75
83.5	54.5	29.0	.25	8.	31.3	52.2	.402	77
84.7	55.0	29.7	.30	9.5	32.3	52.4	.405	80
85.0	55.0	30.0	.30	8	32.2	52.8	.411	80
85.0	54.8	30.2	.20	8	32.5	52.5	.407	80
90.2	56.8	33.4	.15	9	36.1	54.1	.429	82
90.3	56.7	33.6	.15	8	35.9	54.4	.434	83

In continuation of the foregoing, I will now give the Calcutta series, in which sulphuric acid was used in lieu of chloride of lime,

\* This mode of correction was not adopted in my former paper, and the depressions were consequently too low.

and a greater dryness consequently attained; though in some cases I had not the patience to wait until the hygrometer marked 0: in fact, if it did, there was usually enough of moisture in the passages of the gasometer to cause a fall of 1 or  $1\frac{1}{2}$  degrees in the tell-tale hair hygrometer, ere the air reached the vent.

TABLE II. 2nd pt.—Maximum Depressions determined at Calcutta.

Temp. of dry air $t$ °	Wet-bulb Therm. $t'$ °	Observed depression $d$ °	Barom. at 32° B	Hair Hygrom. H	Corrected depression. D °	Corrected wet-bulb $t''$ °	Aqueous tens. at $t'$ $f'$ in	Quotient of $D \div f'$
94.8	57.8	37.0	29.67	5	38.7	56.1	.459	84
94.6	57.3	37.3	.51	1?	37.7	56.9	.471	80
96.4	58.4	38.0	.43	2	40.0	56.4	.462	82
92.0	56.1	35.9	.50	3	37.0	55.0	.442	84
88.7	54.4	34.3	.55	3	35.2	52.5	.406	86
87.0	54.8	32.2	.44	4?	33.4	53.6	.420	79
83.1	52.1	32.0	.50	2	32.5	50.6	.381	85
88.2	54.5	33.7	.46	3	34.6	53.6	.420	82
82.6	51.7	30.9	.50	2	31.4	50.2	.376	84
80.9	51.1	29.8	.55	1	30.1	50.8	.384	78

The same uniformity in the quotients of the last column will be remarked in these two tables, but the average is now 81.8, considerably higher than the Paris result.

Having thus by the ordinary atmospheric temperature of a Calcutta laboratory in May, brought up my train of observations to 96°; and finding that the depressions so much exceeded those for the same portion of the series ascertained at Benares by suspending a wet-bulb thermometer in a vessel of sulphuric acid heated successively from 90° to 140°, I devised the following method of extending the dry-air current series to temperatures still more elevated.

In the first place, the gas-pipe of the gasometer was encased for about four feet of its length in a larger leaden pipe connected with my small steam engine, so that a current of steam could be maintained in the latter during the continuance of the experiments, as is shewn in fig. 2. Pl. XXI. The extremity of the gas-pipe terminated in a glass tube holding, first, a dry thermometer, and an inch further on, the wet-bulb thermometer, inserted through corks.

On letting on the steam, (the two thermometers being stationary at 92°,) one began to rise rapidly, while the other fell very slowly. I could not, however, succeed in getting the former to rise beyond 190°, though the steam itself was at 215°. The wet-bulb then stood at 85°.0 and it fell to 80°.4 at 180°:—80 at 170, and 79.5 at 166. The

\* See Gleanings, I. 79. I purposely exclude these results in the present place, lest they should confuse the view; but they are, nevertheless, valuable in another sense, as shewing the difference, between the depression in calm air and in a current.

fluctuations of the dry thermometer being so considerable for a nearly stationary temperature of evaporation, it was somewhat difficult to determine the exact terms of coincidence; but the above are selected as the best from a great many readings recorded in my note book.

In a second experiment with air containing  $\frac{6}{100}$  ths of aq. ten. at  $94^{\circ}.3$  ( $= \frac{7}{100}$  ths at  $170^{\circ}$ ) the dry thermometer became stationary at  $170^{\circ}$ , with the wet at  $87^{\circ}.7$ .

In a third trial, aq. ten. .65 at  $94.6$  ( $= \frac{6.5}{100}$  at 180) the stationary points were 180, and 90.

In a fourth, dew-pt. 74.3 (aq. ten. = 4.4 at 190) the same points were 190 and  $92.2$ —Bar. 29.50.

Barometer	Thermom. in curt. of air.	Wet-bulb Thermom.	Observed depression.	Cen. aq. tens.	Corr. for do.	Aqueous tens. at $t'$	Quotient $D \div J'$
29.55	190	85	105.0	0?	0?	1.17	89
	180	80.4?	99.6	0	0	1.01	98?
	170	80.	90.	0	0	1.00	90
29.50	190	92.2	97.8	.014	+ 7.2?	1.17	89
	180	90.	90.	.065	+ 7.4?	1.12	87
	170	87.7	82.3	.07	+ 7.7?	1.00	70

Observing the very rapid increase of the evaporating depression with the rise of the temperature, I perceived that I might safely carry my experiment to much higher limits than the boiling point of water. I accordingly next passed the current of dry air through a porcelain tube maintained at a bright orange heat in a Black's furnace (fig. 3, Pl. XXI.) At the further end of the tube a lateral hole was perforated to admit the bulb of the thermometer, coated with two-fold muslin that it might hold a larger supply of moisture. It was necessary to watch the experiment carefully, as, the moment the water was removed, a sudden rise took place, which would have otherwise broken the thermometer, while the cloth and cork were instantly charred with the heat. The actual temperature of the dry current was then estimated in the following manner: a thermometer, with the tip of its stem left open, was held mid-tube in the position previously occupied by the wet-bulb. In a few minutes the mercury boiled off, shewing that the temperature somewhat exceeded  $656^{\circ}$ . A very thin slip of tin was instantly fused: one of lead was then held within the tube, but it required to be passed a little in advance of the position of the wet-bulb ere it melted:—we may therefore assume the heat of the dry air to have been under  $700^{\circ}$ . Two experiments agreed precisely in giving the temperature of evaporation  $145^{\circ}$ . With a very rapid current the wet-bulb thermometer fell to  $144^{\circ}$ , but probably the air had not then time to get thoroughly heated in traversing the furnace.

There would have been little satisfaction in carrying this train of research further, because of the difficulty of measuring the temperature; otherwise it is evident that the coated thermometer might be safely trusted in a much greater heat, ere it would itself reach even the boiling point of water under the ordinary pressure; an illustration of which will be hereafter mentioned, but, not being strictly experimental, it cannot be introduced here.

Having however accumulated abundant data for the formation of an experimental curve, I may proceed to throw them together in the form of a diagram (fig. 4.), and to compare at once the results with the various formulæ that have been proposed by different philosophers.

As, however, each author has employed different algebraic characters for working out the problem, it will be better first to bring them to common terms, adopting the most simple expressions: thus let

$t$  = the temperature of the air.

$t'$  = the temperature of a wet-bulb, or of an evaporating surface.

$t''$  = the temperature of saturation, or the dew-point.

then  $f$ ,  $f'$ , and  $f''$  may be conveniently used to represent the *force of aqueous vapour*, at  $t$ ,  $t'$ , and  $t''$  respectively.  $d$ , the depression, is of course =  $t - t'$ , and not absolutely wanted, but it is frequently a more convenient expression; and  $D$  may be also used to distinguish the *maximum depression* in dry air, when  $f'' = 0$ .

Now supposing the increasing temperatures,  $t$ , to be represented by the abscissæ of the divided line TT, the observed depressions may be laid off as ordinates, through the apices of which a dotted line being drawn, will form an *experimental curve of maximum depression*, for which a mathematical expression is required.

Next, to collect the materials for the theoretical curves to be entered in the same diagram, we must take a cursory view of the existing theories.

LESLIE, who must be regarded as the inventor of the wet-bulb hygrometer, deserves the precedence in this inquiry. His experiments were conducted by approaching a dry and a wet thermometer together gradually towards a heated furnace in a closed chamber. The Professor calculated the hygrometric conditions of the air as its heat rose; and on comparing his results, he was led to the conclusion, that as the caloric necessary to convert water into steam was = 6000 degrees of his instrument, and the capacity of air was  $\frac{3}{8}$ ths that of water, the same measure of heat would raise an equal mass of air, 16000 degrees; and consequently that at the temperature of the wet-bulb,  $t'$ , air would take up the 16000th part of its weight for each

degree marked by his hygrometer, which is equal to the 2880th part for each degree of depression by the common thermometer.

Now  $p$  (Barometric height) may be substituted for the weight of the air, and  $f'$  for the saturation weight of vapour at  $t'$ : therefore by the above data  $f'$  will be  $\frac{d \times 2880}{30} = \frac{d}{96}$  or, (as  $d$  is the object sought)  $d$  (or  $D$ ) =  $96 f'$ , at the pressure 30.

This simple enunciation, making  $D$  in the direct ratio of  $f'$ , is unduly criticized by M. ANDERSON in his elaborate treatise on hygrometry in BREWSTER'S Encyclopedia; but while in reality it will be found closely to agree with the experimental data, and with the subsequent formulæ of others, the new expression deduced from "the laborious investigations" of the critic, turns out to be wholly at variance with experiment, except accidentally at the temperature of the single trial he has himself recorded: his formula (omitting the correction for the barometer) is  $D = \left(36 - \frac{D}{10}\right) (f - f'')$  which, when  $f'' = 0$ , is convertible into

$$D = f \times 36 - \frac{D}{10}$$

making the depression depend on the tension at  $t$ , instead of at  $t'$ .

M. GAY LUSSAC'S memoir should, I fancy, precede Mr. ANDERSON'S. It was written in 1815, though not published until 1822. The rationale of his formula is explained in these words:—

"Le froid produit (par l'évaporation) est à son *maximum* lorsque le calorique absorbé par la vapeur est égal à celui que perd l'air pour se mettre en équilibre de température et de pression avec elle, plus à celui versé sur la surface évaporante par les corps environnans; mais la quantité de ce dernier, lorsque le froid produit n'est que de quelques degrés, est très petite en comparaison de l'autre, et peut être négligée." If, therefore, on one side the latent heat of vapour ( $l$ ) and its density ( $\delta$ ) be combined with its weight ( $f'$ ); these should counterbalance the weight of air ( $p - f'$ ) combined with its capacity ( $c$ ) and the number of degrees cooled ( $D$  or  $t - t'$ ); that is,  $f' \delta l = (p - f') (t - t') c$

or, at 30 inches,  $f' \times .625 \times 960 = 30 - f' \times d \times .2669$  and

$$D = \frac{2247 f'}{30 - f'}$$

depending as before on  $f'$ . With *dry* air, the divisor in this equation should, I imagine, lose  $-f'$  altogether, which would elicit the value of  $d$ , =  $74.9 f'$ ; a value lower than LESLIE'S, but almost exactly agreeing with M. GAY LUSSAC'S own experiments detailed in Table I.

Captain HERBERT'S formula was founded on the proposition that "when the equilibrium or stationary point of the wet-bulb is attained,

the indefinitely small decrements of caloric from evaporation are balanced by the indefinitely small increments arising from conduction and radiation in the equally small moments of time." Now as Messrs. DULONG and PÉTIT have shewn that the rate at which a body cooled below the temperature of the air (by conduction and radiation) reacquires heat, is proportional not to the simple difference of temperature, but to that difference raised to the 1.233 power; hence it should follow that the amount of evaporation should increase in the same ratio; "but," says he (page 191), "how determine the rate of evaporation? One of the most striking phenomena of evaporation is the cold produced by it; the consequence of the absorption of heat attending the conversion of water into vapour. This depression of temperature must evidently be as the evaporation; or rather the momentary depression will be in proportion to the rapidity of the evaporation. The momentary depression is equal to the momentary increment of heat which would take place were the cooling power of evaporation suspended, and the moistened bulb thermometer allowed to assume the temperature of the air. This is known to be as the 1.233 power of the total depression: the evaporation will then be as the 1.233 of the depression." But the evaporation is (according to DALTON), as the tension of the evaporating surface *minus* the tension of the vapour in the air (= 0 in dry air:) then finally this tension will be as the 1.233 power of the depression: or

$$d m = \sqrt[1.233]{f' - f''}$$

$m$  being a co-efficient depending on the latent heat of air and the ratio of the evaporation to the weight and surface necessary to produce a fall of one degree; which Captain HERBERT deduced from the experiments made at Benares. The complete formula, at 30 inches, for dry air becoming

$$D = \sqrt[1.233]{\frac{L f'}{6.056}}$$

in which  $L$  (proportion of mass of water to the vapour required to be evaporated to produce a fall of  $1^\circ$ ) is derived from a table published in the *Oriental Magazine*, September 1827; it varies from 898 at  $40^\circ$  to 1005 at  $90^\circ$  and 1250 at  $1800$ . The divisor 6.056 would require to be diminished to 5.4 to suit the present experiments, but neither would the formula then agree so well as the more simple one of LESLIE and others. The fact is that the experimental curve is of so simple a nature, that any geometric series of moderate divergence may within limits be accommodated to it by proper co-efficients: thus my

own formula was merely an empiric one formed to represent the experimental data of Benares and those of GAY LUSSAC in the most ready manner, expressing the depressions in terms of the temperature of the air: the former increasing geometrically with arithmetical increments of the latter, I found  $d = t' \frac{1.275}{8.91}$ ; but this does not correspond at all with the higher depressions now ascertained experimentally, though it suits those of the former series. We may, therefore, reject it without further regard: nor need we pause to consider BERZELIUS' more simple rule, founded, he says, on the experiments of AUGUST, BONENBERGER and others, viz. that the temperature of the wet-bulb is always an arithmetical mean between that of the air and the dew point, or  $t'' = 2t' - t$ , which, except at certain points of the scale, is utterly erroneous.

We now come to Professor APJOHN's formula, which will be found not to differ essentially from those of LESLIE or GAY LUSSAC. It is  $f'' = f' - m d$  (at 30 inches pressure) where  $m$  is a co-efficient as usual "depending upon the specific heat of air, and the caloric of elasticity of its included vapour," of which the arithmetical value deduced from received data is .01149 or the equivalent vulgar fraction  $\frac{1}{87}$  at  $50^\circ$  Farh. Now in the case of extreme dryness assumed for our comparison,  $f'' = 0$ ; therefore  $d = 87 f'$ ; an expression entirely agreeing in form with LESLIE's, but rather smaller in amount, and more nearly, as will be seen, in accordance with the experiments of Tables II and III.

Dr. HUDSON arrives, from different premises, at nearly the same method as Professor APJOHN\*. He calculates a column of the "relative quantities of heat (Q) necessary to supply vapour of saturation to dry air at each degree of wet-bulb temperature,  $t'$ , and then finding from experiment at one point ( $t' = 61^\circ$ ) the actual depression (51.124 APJOHN), the depressions at other degrees he assumes to be direct proportionals, or  $Q$  (at  $61^\circ$ ):  $Q' :: 51.124$ ; D.

Now it is evident that in this equation, as in most of the preceding,  $Q$  (whence D is directly derived) necessarily depends on the aqueous tension,  $f'$ , affected by the indispensable co-efficient of the latent heat of water, vapour and air, or as Dr. HUDSON deduces from DESPRETZ's values,  $Q = \frac{1168 - t \times 22 f' \dagger}{448 + t}$ . For

\* Phil. Mag. Oct. 1835, p. 257.

† If the theory which makes the sum of the latent and thermometric heat for gaseous bodies a constant quantity be correct, Dr. HUDSON's expression does

ordinary temperatures,  $Q$  on an average will be found  $= 50 f$  and  $D$  is assumed from APJOHN'S experiments  $= \frac{51.124}{25.9} Q = 1.9 Q$ ;

so that by this formula (at 30 inches,)  $D = 98 f$ , nearly; being a little in excess of LESLIE'S original formula. This is attributable to APJOHN'S single experimental depression assumed as the basis of the whole calculus being somewhat too great.

It cannot be said after the preceding list, that the wet-bulb theory has been neglected. On the contrary, it may be rather feared that the researches of its earliest investigators, particularly those of LESLIE and GAY LUSSAC, have been neglected; for it is certain that their formulæ are nearly as well adapted to the actual phenomena as any that have been since suggested. This cannot be more strikingly exemplified than in the accompanying diagram, (Pl. XXI.) which has been filled up from the preceding data. The abscissæ represent the temperatures ( $t$ ), and the ordinates the maximum depressions in dry air ( $D$ ). The experimental determinations are shewn by dots\*, and the principal theoretical curves delineated, are distinguished by the name of their authors.

The following table also embraces a comparative view for every ten degrees of temperature, the experimental entries being adapted by interpolation from the observations before set forth.

not seem open to objection. The volumes of air at different temperature being as  $448 + t$  directly: the densities are as  $448 + t$  inversely; and for any other pressure  $\frac{f}{30}$  the density of air at  $t$  will be  $\frac{660f}{448 + t \times 30} = \frac{22f}{448 + t}$ . Further, allowing the atomic theory of volumes, the density

of vapour at  $t$  will be  $= \frac{.625 \times 22f}{448 + t}$ . Compounding this expression with that of the latent heat of vapour at  $t$  which is  $1168 - t'$  (being 956 at  $212^\circ$ ); we have as above the quantity of heat necessary for the vapour of saturation at  $t = \frac{1168 - t' \times 22f'}{448 + t}$ . The author has steered clear of what he considers the

disputed points, of the capacity of air and vapour for heat: but it may be reasonably doubted whether the assumption of the equality of  $t + t'$  be a whit more tenable.

\* In the portion of the curve marked "PRINSEP'S experiments," both the uncorrected and the corrected observations are entered; the latter, distinguished by a dotted line passing through them, are alone to be attended to. The corrected places of the sulphuric acid experiments have been omitted, because they are necessarily doubtful. The flexure of GAY LUSSAC'S curve seems to be the most suitable to experiment, were its ordinates a little increased.

Depressions of Wet-bulb Thermometer in dry air.

Temperature of the air by Fahrenheit's Thermometer

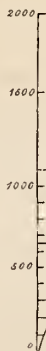
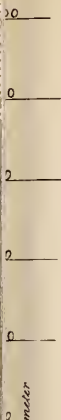


fig 5.

Depression = 90 f'

fig 4

with still air over sulph acid  
Gay Lussac's formula

Anderson's formula

Prévost's Experiments

Hutton's formula

Weyl's formula

G. L. Experiments  
Leslie and  
Lussac's formula

fig 3

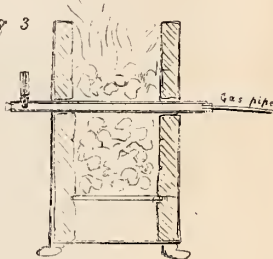


fig 1

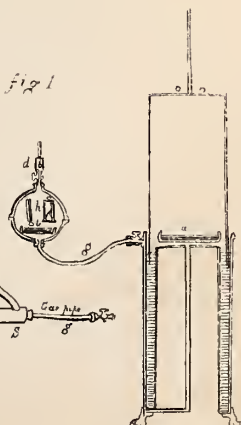
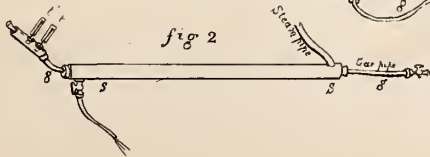


fig 2





TAB. III.—Comparison of various formulæ for the depression of the wet-bulb thermometer in a current of dry air, with the results of experiment.

Calculated depression for Bar. 30 inches.											
Temperature of the current of dry air.	Temperature of the wet-bulb therm.	Observed depression.	Observer's name.	Leslie's formula $D = 96 f'$ .	Gay Lussac's form. $D = \frac{2247 f'}{30 - f'}$ .	Prinsep's formula $D = .0112 t^{1.275}$ .	Herbert's formula $D^{1.233} = 156.8 f'$ (nearly.)	Hudson's formula $D = 98 f'$ (nearly.)	Apjohn's formula $D = 87 f'$	Formula adopted for tables $D = 84 f'$ .	Error of ditto from observation.
$t$	$t'$	$D$		$D$	$D$	$D$	$D$	$D$	$D$	$D$	
30	20.8	9.2	G.	11.7	9.2	8.6	11.0	..	10.8	10.6	
40	27.3	12.7	G.	14.9	13.1	12.4	13.5	..	14.0	13.6	
50	33.9	16.1	G.	18.6	16.4	16.4	16.7	..	17.6	17.1	+0.1
	33.0	17.0	A.								
60	40.1	19.9	G.	22.9	20.6	20.7	20.0	23.4	21.8	21.3	-0.3
	38.4	21.6	A.								
70	46.0	23.7	G.	27.6	24.9	25.2	24.0	28.1	26.4	25.9	+0.2
	44.9	25.7	P.								
80	..	30.6	P.	32.7	29.7	29.9	28.4	33.2	31.3	30.8	+0.2
90	..	35.5	P.	38.2	34.6	34.7	33.1	38.4	36.5	36.0	+0.5
100	..	40.8	P.	44.0	40.0	39.7	38.2	44.0	42.2	41.6	+0.8
110	..	47.8	S.	50.0	46.0	44.9	43.5	49.0	48.3	47.6	-0.2 ?
120	..	54.1	S.	56.4	52.0	50.2	49.2	56.0	54.5	53.9	-0.2 ?
130	..	60.9	S.	63.1	58.6	55.6	55.1	62.2	61.1	60.5	-0.4 ?
140	..	68.2	S.	70.0	65.5	61.0	61.3	..	68.0	67.3	-0.9 ?
150	..	74.8	C.	..	72.4	66.7	..	..	75.1	74.3	-0.5
160	..	81.3	H.	..	79.4	72.5	..	..	82.3	81.5	+0.2
170	80.0	90.0	P.	..	87.0	78.2	79.8	90.4	89.6	88.9	-0.1
180	80.4	99.6?	P.	..	94.6	84.2	..	..	97.2	96.5	-3.1 ?
190	85.0	105.0	P.	107.0	102.0	91.2	98.	102.0	105.0	104.3	-0.7
200	..	..	..	..	109.5	96.4	..	..	112.0	111.1	
210	..	..	..	..	..	102.4	..	..	120.0	118.	
?	145.0	..	P.	627.	625.	105.	308.	487.	567.	552.	

[The letters in column 4 denote, G. GAY LUSSAC; A. APJOHN; P. PRINSEP; S. experiments tried at Benares, by suspending the wet-bulb thermometer in a half filled bottle of sulphuric acid; these have been augmented 10 per cent. on insertion:—C. and H. Carbonic acid and Hydrogen gas heated in the steam pipe.]

The last line may be looked upon, in some measure, as the test line of the various formulæ: for, the hot current of air from the furnace, we have seen, barely melted lead and boiled mercury; its temperature, therefore, could not much exceed 660 Farh. Let us see what it would be according to the principal formulæ depending upon the aqueous tension at  $t'$ , which, when  $t' = 145^\circ$  is 6.53 inches by DALTON.

LESLIE'S formula gives  $6.53 \times 96 + 145 = 772^\circ$

GAY LUSSAC'S (retaining  $f'$ )  $6.53 \times 95.7 + 145 = 770$

(omitting  $-f'$  in divisor)  $6.53 \times 782 + 145 = 655$

HUDSON'S formula gives  $487 + 145 = 632$

APJOHN'S. . . . .  $6.53 \times 87 + 145 = 702$

Formula deduced from my expts.  $6.53 \times 84 + 145 = 697$

ANDERSON'S, HERBERT'S, and my former formulæ are too much at variance at this high point to be worthy of quotation. The rest

agree remarkably well, and it does not materially signify, nor is it perhaps possible to certify which multiplier is to be preferred. Professor APJOHN's has the merit of coinciding precisely at the temperature of  $190^{\circ}$  with my steam experiment; but for the range of lower and more practical temperatures it is perhaps slightly in excess. The simpler expression of "one-eightieth of the depression = the aqueous tension at  $t$ " would there be nearer the mark; and would be easier of application. From my own experiments I deduced a mean of  $D = 84 f'$  with which I constructed the table at the conclusion of this paper, but I must in fairness acknowledge that its preference to Professor APJOHN's rule is nearly evanescent in practice.

§ 2.—*Value of depressions less than the maximum, in centesimal hygrometric tension.*

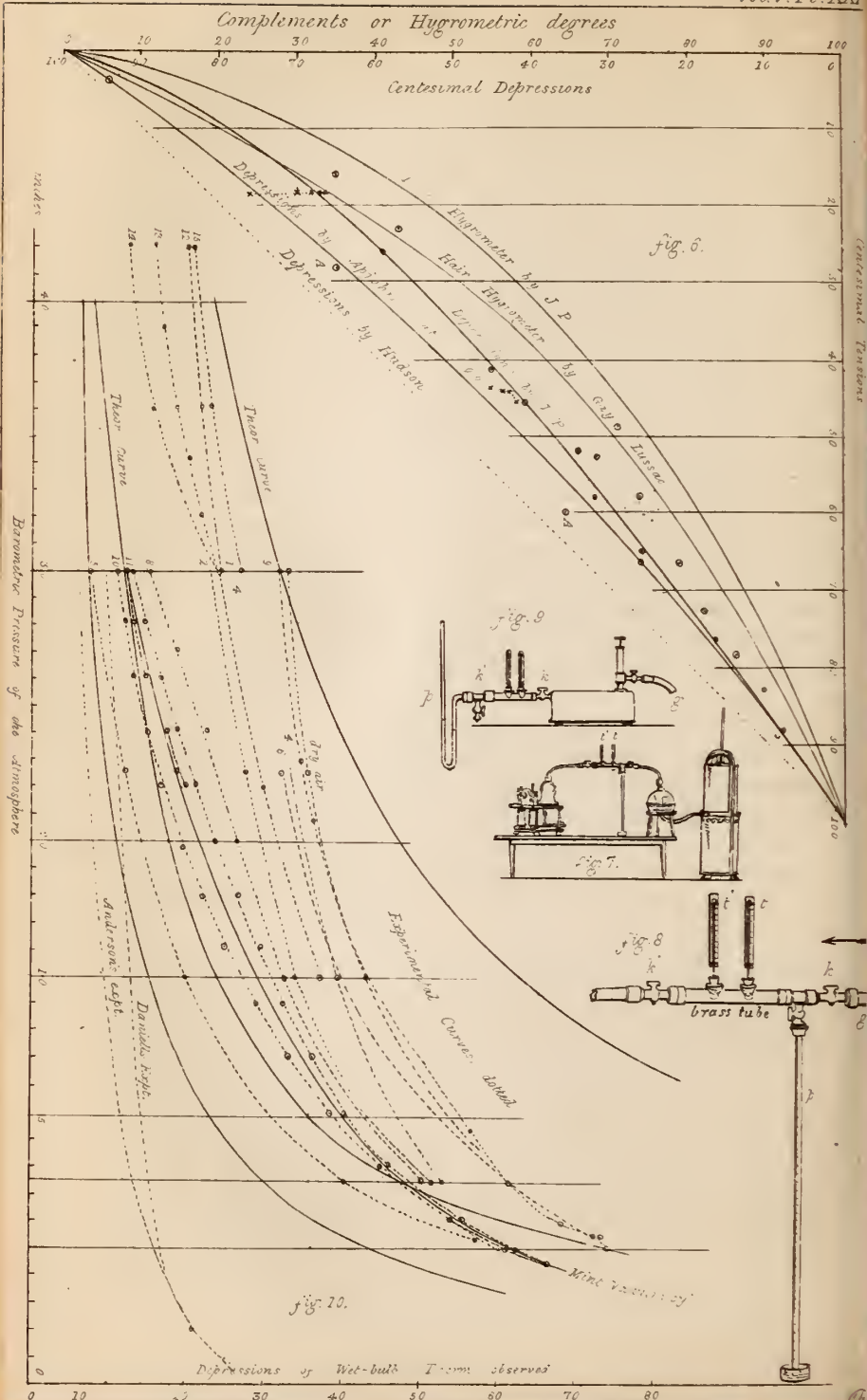
We are now arrived at the second subject of inquiry, which is in fact of more practical importance than the first, since it includes every observation that can be made in an atmosphere never reduced to a state of absolute siccity.

The simplest condition of the case of *intermediate depressions* would be that assumed by Dr. HUDSON, viz., that the maximum depression being divided into 100 parts, each part should indicate one hundredth of the moisture of saturation at the given temperature, or  $D : d :: f' : f' - f''$ .

But such a law is not found to prevail in reality: nor is it analogous to the course of nature that it should exist in the case of the wet-bulb thermometer, when the hair-hygrometer and the law of evaporation require different ratios. It is more consonant with theory\*, as it proves to be with practice, that the tendency to evaporation, and the cold consequent upon it, should increase in a geometrical ratio to the dryness of the air.

\* The depressions will, *ceteris paribus*, be less, the more aqueous vapour is previously contained in the air, because the specific heat of a given volume of vapour being .529 (or  $.847 \times .625$ ) while that of air is .267, the specific heat of any mixture of the two must exceed that of air alone. But the curvature imparted to the line of depressions from this cause may easily be shewn to be trifling. Thus at the temperature of  $80^{\circ}$  where  $f = 1.00$  inch; the capacity of dry air being  $c$ , that of moistened air will be  $\frac{c \times p - f'' + c' \times f''}{p}$ ; whence, calling  $c = 1$ , for saturated air we should have the specific heat 1.053; and for half-saturated air, 1.031; and the depressional degrees at those points will be inversely so much less than those at the dry extremity of the curve. Were the other agents easily evaluated, we might through this means verify the specific heat of aqueous vapour.





Before proceeding to detail the experiments directed to the elucidation of this point, it may be as well, as we have already become acquainted with the theoretical expressions of other authors for the *maximum*, to see how they also bear upon the *intermediate* depressions.

The formula of M. GAY LUSSAC makes no provision for aught but the maximum depression; but the omission may be readily supplied on the same simple principle as has been adopted by Professor APJOHN; namely, by the addition of  $-f''$ , the aqueous tension at the dew-point, to  $f'$ : thus, by the latter author, in all cases  $d = 87 f' - f''$ .

At first sight, this would seem a simple arithmetical ratio, like Dr. HUDSON'S, but inasmuch as the tensions ( $f$ ) are themselves in geometrical ratio to the temperature ( $t$ ), the same parabolic curvature will extend to the centesimal depressions; or  $f' - f''$  will follow some low power of  $t - t'$ .

Captain HERBERT'S rule has the same happy introduction of  $f''$ . We have therefore but two theoretical enunciations to put to the test of comparison with experiment: for which purpose I will now bring forward such evidence as I have accumulated. In this branch of inquiry materials are so numerous in my registers kept at Benares and Calcutta, that it becomes expedient to gather selected data into groupes adapted to elucidate various points of the hygrometric scale. Moreover, as unity, or the maximum depression, varies in amount at each temperature, all observations must be brought to common centesimal terms before they can be compared in the manner which is best adapted to give a quick perception of the relation of such phenomena; namely, by a diagram, as in Pl. XXII. First, then, to enumerate the data afforded by method 5, or comparison with the dew-point, of which, in addition to my Benares observations, I have profited by the presence of an American ice-house on the banks of the Húghlí to collect an accurate series made thrice per diem in the hottest period of our Calcutta year.

TABLE IV.—Comparison of intermediate Depressions with aqueous tensions, ascertained by the dew-point method, at Benares.

Number of observations agreeing closely in their respective particulars.	Temp. of air.	Wet-bulb.	Dew-point.	Centesimal tension.	Depression. $t - t'$ or, $d$	Completion cent. depn. $D - d$	Tabular centesimal tension deduced.	Error.
	$t_0$	$t'_0$	$t''_0$	$f'' \div f$		$D$		
7 Obs. mean,	85.0	81.5	79.4	.83	3.5	89	.84	+01
12 Obs. ditto,	87.5	81.8	78.7	.76	5.7	83	.76	0
12 Obs. ditto,	90.0	80.5	75.7	.65	9.5	74	.64	-01
6 Obs. ditto,	94.0	81.0	73.2	.52	13.0	66	.54	+02
6 Obs. ditto,	92.5	75.5	64.5	.41	17.0	55	.40	+01
13 Obs. ditto,	88.2	67.3	42.9	.23	20.9	43	.26	+03
8 Obs. ditto,	92.6	68.3	36.4	.16	24.3	35	.20	+04

## Second series, from observations in Calcutta.

	$t$	$t'$	$t''$	$f' \div f$	$d$	$\frac{D-d}{d}$	Tab.	Err.
6 Obs. open air,	82.1	79.4	78.1	.88	2.7	.92	.88	0
6 Obs. ditto,	84.6	79.9	76.7	.78	4.7	.86	.80	+02
9 Obs. ditto,	85.6	79.7	75.5	.73	5.9	.82	.75	+02
15 Obs. ditto,	87.7	80.2	74.6	.66	7.5	.79	.70	+04
2 Obs. ditto,	96.0	85.6	78.3	.58	10.4	.74	.64	+06
3 Obs. ditto,	93.8	82.9	71.2	.49	10.9	.71	.60	+11?
4 Obs. ditto,	87.3	76.4	67.3	.53	10.9	.68	.58	+05
3 Obs. ditto,	97.1	80.8	71.3	.45	16.3	.59	.45	0
6 Obs. ditto,	97.3	73.6	55.5	.26	23.7	.41	.26	0
1 Steam pipe,	19.0	92.5	74.3	.04	97.5	.6	.04	0
3 Vacuum-pipe	92.8	80.8	74.8	.58	12.0	.68	.57	-01

## Third series, extracted from other observations.

7 Obs. by Herbert on river Ganges,	91.4	82.1	78.1	.66	9.3	.74	.65	-01
6 Obs. by Apjohn, . . . . .	70.0	60.8	54.5	.60	9.2	.64	.52	-08
4 Obs. ditto, (heated air,)	93.2	69.0	53.7	.28	24.2	.35	.22	-06

In the following series the air was dried to two fixed points of hygrometric tension by means of sulphuric acid, of which the drying power was known beforehand by the table which I published, from careful experiment, in my note on the hair hygrometer before alluded to; but I preferred verifying those determinations by fresh measurement of its barometric tension, in the mode I had adopted to correct the tables of aqueous tension during the past year; namely, by moistening a barometer tube with the acid solution, and mounting it in the ordinary manner. The daily readings registered in my monthly tables for May-June afforded a more accurate average than a cursory trial could have yielded; but the result was in perfect accordance with my former determination\*.

## Fourth series—current of air partially dried.

Number of observations in similar circumstances.	Temp. of air.	Wet-bulb.	Known cent. tension.	Hair Hygrom.	Depression. $t - t'$ or, $D$	Comple- ment cent. dep. $\frac{D-d}{D}$	Tabular centes. tension.	Error.
	$t$	$t'$						
2 Obs. with gasometer current, Sulph. acid, 1.344, . . . .	90.2	75.3	.45	75	14.9	.58	.45	0
2 Obs. ditto, . . . . .	87.2	72.1	.44	74	15.1	.56	.43	-01
2 Obs. ditto, . . . . .	90.3	74.4	.44	74	15.9	.56	.43	-01
1 Obs. ditto, . . . . .	96.4	79.4	.44	74	17.0	.57	.44	0
1 Obs. ditto, . . . . .	94.0	76.6	.43	73	17.4	.54	.40	-03
2 Obs. sulph. acid, 1.48, . . . . .	88.8	65.2	.18	43	23.6	.33	.20	+02
1 Obs. ditto, . . . . .	87.7	61.1	.18	43	26.6	24?	.12	-06
1 Obs. shorter tube,	84.4	62.0	.18	43	22.4	.32	.18	0
2 Obs. brass tube, ..	87.8	64.3	.18	42	23.5	.30	.17	-01

\* It will be seen by the Meteorological Register for May 1836, that pure sulphuric acid caused the barometric column to be higher even than a boiled tube. This must be attributed to capillarity, which is negative with mercury, but acts in an opposite sense with acid or water. No allowance is made for capillarity in my registers.

On inspection of the columns of complementry centesimal depression and centesimal tension in all the foregoing tables, the constant excess of the former is their first predominate feature; whence the certain conclusion that the ratio is not *direct*. But to arrive quicker at a conclusion of what it may be, let us view the position of the whole series in diagram 6, Pl. XXII. Here the base line designates the hygrometric tensions  $f'' \div f$  and the ordinates denote the corresponding centesimal depressions  $D - d \div D$ . If amid such a straggling and scattered nebula it be allowable to trace a normal line, the curve  $D - d$  will have a preference over any other. Pursuing its dubious course, it passes through the two principal test groupings, upon which more dependence ought to be placed than upon isolated comparisons with the dew-point in still air. Now this line  $D - d$  nearly coincides with the curve I suggested in 1829, from my Benares experiments, making  $H$  (or  $f'' \div f$ ) follow the ratio of  $D - d^{1.5}$ ; or, calling  $D = 100$ ,  $H = \frac{D - d^{1.5}}{100}$ ; in other

words, the *centesimal tension* is as the difference of the actual and the maximum depression raised to the 1.5th power; a form obviously very convenient to be worked by logarithms. This formula has been used for constructing my general table; and its errors may be judged of by the last two columns of the preceding experiments: but it need by no means supersede the elegant formula  $d = 87 f' - f''$  when the table is not at hand. The curve corresponding to the latter formula at  $90^\circ$  is also entered in fig. 6. At lower temperature it will have less flexure.

On the same diagram I have traced the curve of the hair-hygrometer indications, both according to GAY LUSSAC's data and those of my original plate in BRANDE's Journal, on purpose to shew that the *depression curve* passes between the two near the summit:—it was hence I derived the rule for correction of the rough maximum depressions, (Table I. II.) by taking it in the direct ratio of the hair-hygrometer indications: and the near accordance of the maxima so deduced, with the observed maxima in dry air, is an additional testimony in favor of the assumed parabolic curve.

It seems an unmerciful increase of the tax upon my reader's patience to extend this train of comparison further: yet it would be hardly fair to omit any thing that can tend to elucidate the subject or assist future investigation: I will not, therefore, forego, through a false and unphilosophical delicacy, the insertion of an abstract I had prepared for my own satisfaction, of three years' comparative deductions from the wet-bulb and hair-hygrometer. It detracts somewhat from its value, that a constant index error of 4 degrees has to be subtracted from the readings of the hair-hygrometer during the period in ques-

tion. This I only discovered on checking all the instruments, as is my custom, before commencing the present experiments; but the hygrometer has been untouched during the interval, and as its scale embraces the 100 degrees with as much sensibility as when it was constructed in 1825, there can be no hesitation in making the required correction throughout. The extreme points of this instrument should indeed be verified at least once in a year; as the index point is, from its delicate construction, easily shifted 2 or 3 degrees.

TAB. V.—Comparison of the monthly averages of the Wet-bulb depression, and the Hair-hygrometer, for 3 years in Calcutta.

	At 10 A. M.			Tension,		At 4 P. M.			Tension,	
	Temp.	Dep.	Hyg.	by Dep.	by Hyg.	Temp.	Dep.	Hyg.	by Dep.	by Hyg.
Jan. 1833	68.0	8.4	81	.55	.61	72.4	11.6	74	.47	.49
1834	67.5	6.4	83	.64	.64	71.1	9.2	76	.53	.52
1835	67.8	8.0	80	.56	.59	70.7	11.5	70	.42	.43
Feb. . . 1	74.0	8.2	82	.60	.63	78.7	12.7	74	.44	.49
2	74.0	7.3	86	.64	.70	77.8	11.6	77	.48	.54
3	74.3	6.0	87	.70	.72	76.6	10.2	76	.52	.52
Mar. . . 1	83.5	9.8	81	.59	.59	89.2	17.3	66	.37	.43
2	82.3	7.5	86	.67	.68	86.7	12.2	76	.52	.52
3	79.8	8.3	85	.63	.66	83.6	13.0	70	.47	.44
April, 1	87.5	6.2	88	.75	.74	91.6	10.8	79	.60	.57
2	86.5	8.8	84	.65	.67	93.2	13.8	75	.52	.51
3	84.6	7.6	86	.68	.70	88.1	12.7	75	.52	.51
May, . 1	87.5	6.1	91	.75	.80	90.0	8.2	86	.67	.70
2	90.7	7.9	86	.69	.70	94.6	10.9	80	.58	.59
3	86.8	6.5	89	.74	.76	88.3	7.5	86	.79	.70
June, . 1	90.5	6.4	88	.75	.74	92.8	8.1	82	.70	.66
2	87.0	4.8	91	.80	.80	87.8	6.1	90	.75	.78
3	86.1	5.6	87	.76	.72	87.4	6.9	85	.72	.68
July, . 1	86.3	4.0	91	.83	.80	87.9	4.6	90	.83	.78
2	86.6	5.1	91	.80	.80	88.0	6.0	90	.76	.78
3	82.7	4.0	88	.77	.74	85.3	4.8	88	.80	.74
Aug. . . 1	85.0	4.1	92	.82	.82	86.8	4.9	89	.75	.76
2	85.1	4.2	92	.82	.82	86.7	5.3	91	.78	.80
3	84.0	4.0	92	.82	.82	85.0	4.3	91	.81	.80
Sept. . 1	86.3	4.4	91	.76	.80	88.3	5.5	88	.82	.74
2	85.9	4.9	92	.75	.82	86.4	5.9	91	.76	.80
3	83.7	4.8	91	.80	.80	85.0	6.8	89	.71	.76
Oct. . . 1	85.2	5.6	87	.76	.72	86.8	7.6	83	.69	.65
2	82.9	4.0	83	.82	.84	83.9	5.0	91	.79	.80
3	83.3	6.8	87	.71	.72	85.1	9.3	82	.61	.63
Nov. . 1	79.	6.9	84	.69	.66	82.1	10.1	77	.57	.54
2	79.2	7.5	85	.66	.68	79.4	10.1	78	.55	.56
3	75.6	7.7	85	.64	.68	77.9	10.0	79	.55	.57
Dec. . 1	71.7	5.8	85	.70	.68	74.3	7.2	82	.65	.63
2	72.4	6.1	87	.67	.72	75.7	9.0	81	.57	.61
3	69.8	6.1	84	.68	.66	72.0	8.9	78	.55	.56
Means,	81.2	6.1	86.8	.71	.72	83.8	8.9	81.5	.63	.63

The actual tension of vapour in inches, found by multiplying DALTON'S maximun tension of vapour at  $t$  by the percentage here given, is,

at  $81^{\circ}$ .  $2 = 1.040 \times .71 = .738$ ; at  $83^{\circ}.8 = 1.128 \times .63 = .711$  (or  $.716$  at  $81^{\circ}.2$ ) being at the two periods of the day, on an average, very nearly equal; though, relatively, the air is much drier in the afternoon.

A similar comparison to that afforded by the above table would have been published with my journals for 1825-6 in the Philosophical Transactions for 1827, had the registers been allowed to stand as they were; but the columns of aqueous tension were struck out, although from the elaborate care I had taken in valuing the degrees of my hair hygrometer they were entitled to some reliance. It is, however, not worth while to republish them, as the wet-bulb instrument was then situated outside and the hair hygrometer inside the house\*, and the two columns are not strictly comparable. One little table, however, deduced from four years' daily experiments at Benares, which was also suppressed at home, I think likely to prove useful, while it bears directly on the wet-bulb theory, and exemplifies the truth of the assumption of its immediate dependence on  $f'$ . This table shews the actual evaporation in depth per month, as measured by a small evaporimeter suspended in the open air, for the opposite extremes of the year. The instrument is described in the fifteenth volume of the *Asiatic Researches*. I have collected on the left hand the observed quantities, and have now inserted on the right the theoretical numbers which should express the ratio of evaporation. The results are even more satisfactory than could have been anticipated; and lead to the following very simple rule to find the amount of evaporation roughly in inches per diem. "Multiply the aqueous tension at the wet-bulb temperature by the observed depression in degrees, and divide by 34." Omitting the latter operation, the product will express in round terms the evaporation per month in the open air, or in a moderate breeze.

TAB. VI.—Rate of Evaporation and simultaneous depression observed at Benares.

Months.	Year.	Temp. of air. $t.$	Wet- bulb. $t'$	Depres- sion. $d$	Obsvd. Eva- poration per month inches.	Ditto per diem inch.	Aque- ous ten- sion, $f$ .	Depres- sion $\times$ $d \times f'$ .	Calculated daily eva- poration, $d \times f'.$ 34
April and May,	1823	88.0	68.9	19.1	13.9				
	1824	93.1	71.8	21.3	11.9				
	1825	92.3	74.2	18.1	14.7				
	1826	90.4	69.8	20.7	15.1				
	Means	91.2	70.9	20.3	13.9	0.463	0.748	15.18	0.447
March,	1823	79.8	62.0	17.8	8.7				
	1824	81.4	66.5	13.8	6.7				
	1825	75.1	64.7	11.4	4.0				
	1826	80.8	63.4	16.4	9.8				
	Means	79.4	64.1	15.3	7.3	0.243	0.599	8.16	0.240

\* The Calcutta Oriental Magazine, 1827, contains the whole paper.

July and August,	{	1823	80.5	78.2	2.3	2.3	$f'$	$d \times f'$	$\frac{d \times f'}{34}$	
		1824	85.6	82.1	3.5	2.6				
		1825	86.9	81.3	4.6	4.4				
		1826	84.4	80.8	3.6	3.6				
Means		84.4	80.6	3.8	3.2	0.107	1.020	3.88	0.114	
Decem-ber and January,	{	1823	60.1	55.7	4.4	2.3				
		1824	61.8	56.6	5.2	4.0				
		1825	63.5	58.3	5.2	5.6				
		1826	63.8	54.9	8.9	3.1				
Means		62.3	56.3	6.0	2.5	0.085	0.462	2.77	0.081	
						per. an.				
The whole twelve months,	{	1823	76.4	68.1	8.3	65.6				
		1824	80.0	71.2	8.8	60.5				
		1825	80.0	71.1	8.9	67.1				
Means		78.9	70.1	8.7	64.4	0.179	0.729	6.34	0.186	
						permonth	5.37			

I have, as yet, had no opportunity of applying the principle ascertained from this table, to the circumstances of other places\*.

### § 3.—Influence of the Barometer on the Wet-bulb depression.

All philosophers agree in rating the influence of atmospheric pressure on depression as inversely proportional to the height of the barometer; so that when the depression under a pressure of 30 inches is known, it may immediately found for any other pressure by multiplying  $d$  into  $\frac{30}{p}$ ,  $p$  being the observed height of the barometer.

That the evaporation increases with diminution of pressure nearly in the above ratio, has been proved by various experiments; and it might confidently be anticipated, from the necessary connection between the evaporation and the refrigeration, (as exemplified in the concluding table of my last section,) that the same law would prevail in the depressions: but the only two experiments directed to this point that I am acquainted with, lead to an opposite conclusion. These were cited in my former paper: but as they are not accessible to many readers, I will here repeat them. Mr. DANIELL's experiment will be found in Jour. Roy. Inst. XVII., and Mr. ANDERSON's in BREWSTER's Cyclopaedia, Art. Hygrometry.

Barometric pressure.	Ratio.	Evaporation in grains by Daniell.	Depression of wet-bulb by Daniell.	Increment.	Depression of wet-bulb by Anderson.	Increment.
30.4	1	1.24	9	0	5	0
15.2	$\frac{1}{2}$	2.97	12	+3	9	+4
7.6	$\frac{1}{4}$	5.68	15	+3	13	+4
3.8	$\frac{1}{8}$	9.12	18	+3	16	+5
1.9	$\frac{1}{16}$	15.92	21	+3		
.9	$\frac{1}{32}$	29.33	24.5	+3.5		
.5	$\frac{1}{64}$	50.74	26	+1.5		

\* The tables now published by the astronomer at Madras will afford good data; but his mode of measurement must be first known, as his evaporations seem double of my own.

Now in these instances the evaporation certainly followed the inverse pressure law; but the depression was made to receive only a constant arithmetical increment for each geometrical decrement of the pressure; in accordance with which I assumed that the proper correction for variation of pressure should be  $d\sqrt{\frac{30}{p}}$  rather than  $d\frac{30}{p}$ ; and even this would require a different co-efficient to make it suit the two cases quoted above. Under such an uncertainty as to the real amount of this important correction, I was induced to direct a fresh series of experiments to this particular object; and as my results differ greatly from what has preceded, it is incumbent on me to describe my process a little in detail.

I first prescribed to myself the necessity of working with a current of air as similar as might be to that of the maximum series, as without such a precaution it would be impossible to ensure the permanent hygrometric status of the air in contact with the wet-bulb. The bell glass of an air-pump, under which I imagine the experiments of DANIELL and ANDERSON to have been conducted, could not possibly fulfil this indispensable condition, since a partial halo of moisture would encircle the bulb of their thermometer;—nor do they appear to have used a hair hygrometer to inform them how far this might be the case. Mr. DANIELL it is true had a dew-point instrument fitted into the side of the glass receiver, but for slight aqueous tension this instrument becomes wholly useless. The extent to which his air was dried can be calculated pretty well from his own datum that the depression at 50° was nine degrees, which by my table would indicate centesimal tension .30: or by APJOHN's formula  $\frac{.263 - (9 \div 87)}{.357} = .42$

in the latter case requiring a cold of 8 degrees, and in the former of 16, below the freezing point to produce deposition.

But to return to my own experiments:—

In place of the short open glass tube connected with the gasometer and glass balloon in which the wet-bulb was before exposed to the current of air, (fig. 1,) a thin horizontal brass tube (fig. 7) was substituted, having two lateral apertures for the admission through corks, air-tight, of the dry and wet thermometer bulbs ( $t, t'$ ). From the same brass tube descended a glass barometer tube ( $p$ ) into a reservoir of mercury, similar to the gage of an air-pump, for marking the actual pressure close to the thermometers. The other end of the tube was conducted by a flexible pipe  $F$  to the receiver of an air-pump, where a continual vacuum could be kept up by pumping without intermission during the course of an experiment.

and by manœuvring the stopcocks ( $k$ ,  $k'$ ) at the two ends of the brass tube, the pressure could be maintained at any point, and the draft of air regulated until the temperature of the wet-bulb had been satisfactorily ascertained.

Finding that the labour of working the pump was rather irksome in a climate of  $95^{\circ}$ , I afterwards availed myself of the vacuum engine of the coining-press room in the Mint to relieve me from this duty. In the pipe leading from the twelve recoil-pumps of the presses a vacuum of about (or rather 30—27) inches is constantly maintained by the steam engine, so that by adapting the tube F to this with a stopcock, I was enabled to regulate the pressure, and prolong each interval with the utmost ease and comfort.

It will be seen from the table of experiments below, that *by employing a current of dry air* the freezing point was readily attained under a pressure of  $7\frac{1}{2}$  inches, while the dry thermometer, only one inch from it, marked  $92^{\circ}$ : whereas all who have tried LESLIE'S process for freezing have found it exceedingly difficult in the hot weather of this country to produce ice with a vacuum nearly perfect. The reason has been already explained: in the latter case the partially moist atmosphere arrests the progress of refrigeration; whereas in the latter, the vapour rising from the evaporating surface is continually removed;—it is, in fact, like sitting under a punkah or without it, an illustration that requires no comment to an Indian reader! Of such influence is the motion of the air in the experiment, that, as will be seen presently, a cold *much below the freezing point* may be attained under a pressure of  $4\frac{1}{2}$  inches, *with common air at  $92^{\circ}$  containing six-tenths of its vapour of saturation* (dew-point =  $75^{\circ}$ ) and without the aid of sulphuric acid, or any other artificial means of previously drying it! This unexpected result opens a wide field for speculation as to the possibility of modifying the apparatus of LESLIE for the artificial production of ice; and I hope, when leisure permits, to resume the thread of this collateral and highly interesting discovery. The nature of the problem teaches us *à priori*, that if a temperature of  $20^{\circ}$  can be attained under a pressure of  $4\frac{1}{2}$  inches, the cold at two inches ought to be many degrees below zero of Fahrenheit's scale!

Out of four experiments made with the air-pump, and eight with the Mint vacuum engine, it will be sufficient, after quoting the numerical results of the whole, and referring to the accompanying diagram (Pl. XXII. fig. 10.) for a comprehensive view of their general bearing, to select two or three of the most regular examples for analytical discussion.

TAB. VII.—Depressions under diminished pressure.

	Temp. of air.	Hyg. tens.	Temp. of wet-bulb, under a pressure of							
	o		30.	22.5	15.	7.5	6.0	5.5	5.0 in.	
1. Expt. with air pump, air dried by Sul. Ac. 1.48,	84.0	.18	61.0	..	56.0	48.				
2. Ditto, corks fitted closer,	84.7	.18	..	..	51.0	..				
3. Brass tube, better fitted,	84.4	.18	62.0	57.0	50.3	32.0				
4. Ditto, careful expt... ..	87.8	.18	64.3	55.0	49.0	35.0				
5. Common air, in Mint vac. tube; dew-point 79°.5,	88.5	.75	81.3	76.4	69.0	48.0	..	32.0		
6. Partially dried, hair-hyg. in balloon av. 34, ..	92.1	.12	64.2	60.1	52.9	31.0	24.0	20.0	18.0	
7. Nearly dry air; hyg. 1°, ..	91.0	.00	58.3	54.4	48.7	30.0	20.4	18.5		
7½. Partly dried; hyg. 12? ..	91.0	.03 ?	..	65.	53.9	..	25.7	20.0		
8. Hygrom. variable, av. 20..	93.2	.05	79.1	75.1	59.6	..	..	..		
9. Dry air; hyg. 2°, ..	92.0	.01	59.5	63.2	56.3	38.5	..	26.4	20.0	

The last experiment is evidently affected with some accidental error, since the depression is *less* at 22.5 inches than at 30. I imagine the external air was admitted through an unobserved leakage of the tube, or a drop of water may have fallen in the tube, and thus moistened the air before it reached the wet-bulb.

I now detached the gasometer and balloon, and admitted the air of the room directly into the tube at stopcock *k* (fig. 8) keeping up a prolonged current at intervals of every two inches of pressure from 30.0 upwards to 5 inches, and then descending in the same manner: taking care to wet the thermometer from time to time as its water evaporated. In ascending the scale I regulated the pressures in the barometer-gage principally by manœuvring the stopcock (*k'*) next to the vacuum pipe, the orifice at *k* remaining constant: whereas in descending, I allowed *k'* to remain untouched while I brought the gage to the desired point by gradually opening the outer stopcock *k*.

The effect of this will be understood on viewing the apparatus: the current of air was considerably stronger in the last case than in the first, and in consequence the depressions are somewhat greater. To this it must be added, that in the ascending scale the depressions will tend to lag below their full amount, while in descending they will err in an opposite sense; all of which is well exhibited in dotted curves numbered 10, 11 of diagram 10. The mean of the two series (marked by a plain line on the diagram) may be assumed as a good foundation for the analysis we have proposed.

*Experiments 10 and 11, on depressions under diminished pressure.*

Temperature of the room 92°.2; dew-point 74°.8 = centesimal tension .58

Hair-hygrometer, 79 = ditto .57

Barom. pres- sure inches.	Ascending series.		Descending series.		Temp. of air.	Depression ascending.	Depression descending.	Mean depression ob- served.	Calcu- lated depres- sion. $30 \times \frac{p}{d}$
	Temp. of air.	Wet- bulb.	Wet- bulb.	Wet- bulb.					
		1	2	3	4				
30	92.7	80.4	82.0 (rewetted)	80.5	93.0	11.7	13.0	12.0	12.
28		79.7	80.8	79.2		12.6	14.3	13.1	12.9
26	92.9	78.0	80.0 (rewetted)	76.8	79.2	13.9	15.5	14.6	14.0
24			77.8	74.7	75.2	15.0	18.0	17.0	15.0
22	92.7		75.4 (rewetted)	72.4	73.8	16.4	20.4	19.1	16.4
20			73.0		70.2	19.8	23.3	21.5	18.0
18			70.3		66.9	22.5	26.6	24.5	20.0
16			67.7		64.2	24.2	29.3	26.8	22.5
14	93.0		64.0		61.2	29.	32.3	30.6	35.7
12			60.0		57.4	33.	36.1	34.5	20.0
10			54.9 (rewetted)	54.6	53.8	38.1	39.7	38.9	36.0
8			48.3	47.3		44.7	45.9	45.3	45.0
6			38.0	38.8	92.5	55.0	53.7	53.1	60.0
5			31.0	30.8	91.6	62.0	60.6	61.4	72.0
4.4			rewetted	23.7	89.8		66.1	66.1	81.8

At the first glance towards the final columns of this table, one might at first be led to exclaim, upon the wonderful accordance between theory and fact! The ascending series, especially, agrees exactly with the calculation in several points, and does not diverge materially until the pressure falls to six inches, far beyond the reach of any likely contingency within our observance.

But all this seemingly agreeable coincidence is, in a measure, delusory. The effect is compounded of two different influences—1, the rarefaction; and 2, the diminution of humidity which is consequent thereon. We know from our second section of experiments how to appreciate this latter disturbing cause, and so isolate the reduction of temperature due to the diminished pressure alone; but the prior experiments give us an opportunity of estimating it in a more direct manner. Thus, taking experiment 7, we have the following data: the temperature being 91°. Fahrenheit. The fourth column contains the hypothetical depressions on the supposition of the inverse-pressure ratio.

Barometrical pressure inches.	Depression in dry air. $d$	Increment observed. $d-d$	Theoretical depression. $d \times \frac{30}{p}$	Increment $d + \frac{30}{p} - d$	Calculated co-efficient. $\Delta \div \delta$
	$\delta$	$\Delta$		$\delta$	
30.0	32.7		32.7		
27.5	35.6	+ 2.9	43.6	+ 10.9	.27
15.0	42.3	+ 9.6	65.4	+ 32.7	.29
7.5	61.0	+ 28.3	130.8	+ 98.1	.29
6.0	70.8	+ 30.1	165.5	+ 132.8	.23
5.5	72.1	+ 39.4	176.5	+ 143.8	.27
5.4	72.8	+ 40.1	179.8	+ 147.1	.27

The rate of increment observed, it will be remarked, here invariably falls short of the calculated rate in the fifth column, but it bears always the same proportion to it, about one-third; as shewn in the sixth column: therefore in this example the law of the inverse pressures holds good relatively, but it requires a co-efficient to reduce the absolute amount. Thus, the maximum depression in dry air at any

pressure will, by the experiment, be equal to  $d + .27 \left( d \frac{30}{p} - d \right)$  instead of  $d + \left( d \frac{30}{p} - d \right)$  (or simply  $d \frac{30}{p}$ ). I will not seek to enquire the cause of this deviation from theory; or whether it be peculiar to the form of apparatus I employed; or whether the effect will be constant under all circumstances:—I will merely suggest that the supply of heat from extraneous sources—the brass tube (only half inch diam.) radiation, &c. could not fail to reduce the cooling effect of the mere current of air; and here we have the measure of their united disturbing power, which it is satisfactory to find constant throughout.

Let us now see whether the same constancy can be traced in the more elaborate experiment with common air (10-11.) The first thing necessary is to calculate the percentage of moisture for each step. Now, as under 30 inches the centesimal tension was found to be .58 by the dew-point, and as no source of fresh supply was at hand, the tension at any other pressure should be directly as the pressure, or inversely as the volume; since it is evident that a double space, for instance, will require twice as much aqueous vapour to bring it to a given state of humidity; the aqueous tension, therefore, will be  $.58 \times \frac{p}{30}$  for this series of experiments. Again, from our table of depressions, (from the diagram or from the formula) can be obtained, with the reading at these variable states of humidity, the depression either in dry air or in air of the initial tension .58. I have, in fact, given both in the following table, and have set in the three last columns the calculated depressions by the expression just found of  $d + .27 \left( d \frac{30}{p} - d \right)$ .

TAB. VIII.—*Experiment 10-11, reduced to a constant hygrometric state.*

Barometer. inches.	Centes. aqueous tension calc. $H \times \frac{p}{30}$	Tabular centesi- mal ten- sion corres- ponding T	Observed de- pression variable aq. tens. d	Deducted depression for aq. ten. .58 $d \times \frac{32}{T}$	Deducted depression for dry air, D = $\frac{100}{T}$ $d \times \frac{100}{T}$	Calculated depression for varia- ble aq. tens. of second column.	Calculated depression for aq. tens. .58	Calculated depression for dry air.
			°	°	°	°	°	°
30	.58	32	12.0	12.0	37.5	12.	12.0	37.5
28	.54	34	13.1	12.2	38.2	13.1	12.3	38.2
26	.50	37	14.6	12.5	39.0	14.5	12.6	39.1
24	.46	42	17.0	12.8	40.1	17.0	12.8	40.1
22	.42	44	19.1	13.8	43.3	18.2	13.3	41.4
20	.39	47	21.5	14.7	46.0	20.1	13.7	42.8
18	.35	50	24.5	15.7	49.0	22.3	14.3	44.6
16	.31	54	26.8	15.9	49.8	25.6	15.0	47.4
14	.27	58	30.6	16.9	52.7	28.8	15.9	49.7
12	.23	62	34.5	17.8	55.5	33.2	17.1	53.5
10	.19	66	38.9	18.6	58.2	39.2	18.7	58.9
8	.15	72	45.3	20.2	63.3	49.4	19.4	69.6
6	.11	76	53.1	22.3	69.8	63.0	25.7	80.4
5	.096	78	61.4	25.1	78.5	71.0	29.1	91.0
4.4	.085	79	66.1	26.7	83.5	78.0	34.8	99.6

With exception of the four lowermost entries, the three middle (or observed) columns of this table accord wonderfully well with the three last, which are calculated by the formula above given multiplied into  $T$ , (the tabular cent. dep.); which is variable in the first of them, (that of the experiments;) is equal to  $\cdot 32$  for the case of humidity  $\cdot 58$ ; and is of course  $= 0$  for the final case, of extreme dryness. Were we to suppose that the dryness of the air did not mount higher than  $\cdot 18$  (second column) from some unperceived cause, the calculated depressions would suit equally well from beginning to end; and it must be remembered that any disturbing force will be much more felt in the low pressures. Moreover, it can hardly be expected that the depression should continue to follow the same law, after the evaporating surface has congealed into ice. Had the ascending series of depressions only been used, instead of the mean, the accordance would have been greater towards the middle of the scale.

It is hardly necessary to analyse any more of the present series, after ascertaining that the same co-efficient is equally applicable to dry and wet air. We may therefore proceed at once to the conclusion, that *the depression of the wet-bulb thermometer, ceteris paribus, varies inversely as the barometric pressure, the actual variation being for every case twenty-seven hundredths of the calculated variation.*

§ 4.—*Depressions under augmented barometric pressure.*

It would perhaps have been better to have preceded the last enunciation, by a description of the experiments included under this head, since they obviously form part of the same series, and must be governed by the same law. They need not detain us many minutes.

The modification of apparatus now employed is depicted in fig. 9. Between the gasometer and the brass tube furnished with the two thermometers was introduced a condensed air blow-pipe; while at the other extremity near the discharge cock  $k'$ , was adapted a syphon barometer capable of shewing an increase of pressure up to  $+ 12$  inches. By keeping up the action of the pump with the discharge cock more or less open, a current of condensed air could be maintained at any pressure until the readings of the wet-bulb became stationary; for, as before stated, it was upon the current only that reliance could be placed; and my endeavour was always to maintain the same rapidity in the passage of the air, although small variations in this particular do not, and ought not, to produce any sensible error.

Not having used a hygrometer in this series, I trust to the depression itself (at 30 inches) to supply the datum of the humidity; and here of course, under condensation, the moisture *increases* directly

with the pressure. On the diagram this is very conspicuous in figs. 13, 14; and as the air approaches dryness, the line formed will be seen amalgamating with the curvature of the former experiments.

TAB. IX.—*Depressions under increased pressure.*

Barom. pres- sure. inches.	First Experiment.			Second Experiment.			Third Experiment.			Fourth experiment.		
	Temp.	Depres- sion.	Hum- idity.	Temp.	Depres- sion.	Hum- idity.	Temp.	Depres- sion.	Hum- idity.	Temp.	Depres- sion.	Hum- idity.
30	93.5	23.5	.24	93.5	23.7	.24	85.0	24.0	.15	86.4	26.8	.10
33		—		93.6	20.9	.26		—			—	
36		21.5	.29	93.8	17.8	.29		14.0	.18		22.8	.12
42		19.5	.34	94.3	15.5	.34	85.2	11.4	.21		20.7	.14

In the last experiment the air was maintained for a long time at each pressure, whence its results are perhaps entitled to greater confidence than the rest. The direct theoretical depressions,  $d \propto \frac{30}{p}$  would be  $26^{\circ}.8$ ,  $22^{\circ}.3$ , and  $19^{\circ}.1$ , which corrected by the co-efficient before found, would become  $26^{\circ}.8$ ,  $25^{\circ}.6$ , and  $24^{\circ}.7$ ; these again would have to be diminished for the altered humidity to  $26.8$ ,  $24.5$ , and  $22.8$ ; still, however, differing materially from the experiment, which I attribute to the difficulty of keeping up a sufficient draft at the high pressures, in consequence of which the humidity is not fairly estimated.

If we examine the first experiment we shall have,

The direct geometrical depressions,.....	23.5	19.6	16.8
These modified by co-efficient, .27....	23.5	22.4	21.7
Corrected to the incipient state of humidity will be,	23.5	20.0	18.1

The observed depressions being in this case,..... 23.5 21.5 19.5 nearly midway between the modified and the corrected numbers, and as much above the latter as they were below them in experiment 4,—so it will be not unreasonable to conclude that our formula would hold good for augmented depressions, if proper care were taken in conducting them.

We have now examined every case of depression that can be experienced in common air, and we may finally sum up this lengthy investigation by uniting the members of the formula, that it may comprehend both changes of humidity and changes of atmospheric pressure thus:—

$$d = 84 f' - f'' + .27 \left( \frac{d}{p} \frac{30}{p} - d \right).$$

The latter member of the equation may be converted into a table of multipliers for heights of the barometer other than 30, which will leave the table I have appended to the present paper applicable to all

circumstances that can occur. The rule for its use will be given in the proper place.

§ 5.—*Depression of wet-bulb in other gaseous media.*

It has been seen that the theory of the wet-bulb thermometer is entirely based on the relation of the specific heats, or capacities, of water, of vapour, and of air. It may be made therefore to furnish an unexceptionable and easy method of solving the much-contested question of the relative capacity of different gaseous fluids, by substituting any of the latter for common air in the experimental determination of the depression.

By GAY LUSSAC'S formula we perceive that the depression varies precisely in the inverse ratio of the air's capacity,  $c$  (see p. 405.) APJOHN'S formula is based on the same datum; thus the specific heat of vapour at  $50^{\circ}$  being 1129 ( $= 967 + 212 - 50$ ); that of water being 1; and that of air  $c = 0.267$ ; "one part of air in cooling through  $d$  degrees will raise the temperature of 0.267 part water through the same number, and will consequently be adequate to vaporize a quantity of water represented by  $\frac{.267 d}{1129}$ ". Now, as  $.267 d (= c d)$  is a constant quantity, any change in the value of  $c$  must affect  $d$  in an opposite or inverse sense, that is  $c' = \frac{c d}{d'}$ ,  $d'$  being the depression observed in other medium than common air.

As most likely to exhibit any difference of specific heat, and without reference to any prior determination of the question, I selected two gases, *hydrogen* and *carbonic acid*, as far at variance in essential points as could be wished, and proceeded with them exactly as had been done with ordinary air. On account of the mode of preparing the two gases by distillation through a water-trough, they entered the gasometer surcharged with moisture: and, as noticed below, even after being well dried by the acid in the chamber, they took up moisture from the discharge-pipe on their passage to the wet-bulb. I could only approximatively remedy this evil by immediately filling in common air, and finding how much moisture the latter also absorbed in its passage. The error was of course less, if at all, perceptible at the high temperatures, and in a fresh series of experiments it was obviated by the introduction of my tell-tale hair hygrometer.

Wishing to save the gas, it was made to pass into another gasometer instead of into the open air; on which account the current both of hydrogen and of carbonic acid passed more slowly through the steam-heated tube than the air had done, and their temperature only rose to 160 and 170, in lieu of 180 and even 190 as at first. Here follow

the readings which were considered as coincident, but, as before, there was difficulty in keeping the dry thermometer stationary,

TABLE X.—Depressions with Hydrogen gas. First Series.

	Therm. in air. °	Wet- bulb. °	Depres- sion. °	Hygro- meter.	Tension centesimal.	Tabular de- pression in dry air.	Ratio. $d \div D$
1. Through steam pipe,	92.0	67.8	24.2	—	?	37.1	
2. Ditto, steam on, ..	160.0	83.2	76.8	—	nearly dry.	81.5	.94
3. Ditto, ditto, .....	137.0	76.4	60.6	—	ditto.	65.3	.93
4. Ditto, cold, .....	93.8	67.5	26.3	44?	.17?	38.1	

The hydrogen of the gasometer in the first two experiments was supposed to be dry, but it was found that it acquired moisture in passing through the pipes, which had been moistened by the distillation of the hydrogen; the amount of error was estimated by filling common air in, and finding how much its depression differed from the full rate. The gas of 3, and 4 was passed out into a vessel containing the hair hygrometer; but still no great confidence was placed in the series, and on two subsequent days fresh gas was prepared.

Second Series.

5. Protracted current of hydrogen gas,...	85.4	60.0	25.4	
6. Common air treated exactly in the same manner, .....	90.6	59.0	31.6	= 29.1 at 85.4
	Ratio of	29°.1 to 25°.4	as	1.00 to .87

This was still unsatisfactory, as there was no mode of testing the hygrometric state of the gas: I now therefore fitted the glass chamber enclosing the hair hygrometer, (as in fig. 1) and took the following readings after intervals of a day each.

	$t$	$t'$	$d$	$h$	Calc. Maxim. in Hydrogen.	Depress. in Atm. air.	Ratio. $d \div D$
7. Hydrogen, current,	87.8	60.5	27.3	8	29.5	34.8	.84
8. Ditto, full draft, ..	88.0	59.7	28.3	5	29.8	34.9	.86
9. Ditto, ditto, .....	84.0	57.1	26.9	4	28.0	32.8	.85
10. Ditto, ditto, .....	88.5	58.5	30.0	4	31.2	35.2	.88
11. Common air. ....	87.0	54.8	32.2	4?	33.5	34.4	
12. Ditto, .....	83.1	52.1	32.0	2	32.6	32.4	

Still a fourth series was thought necessary; and in this all access of moisture to the tubes being prevented by passing the gas over sulphuric acid before it entered the gasometer, and leaving it for a week to dry thoroughly, the hair hygrometer marked extreme siccidity: precaution was also taken to cool the wet-bulb with ice below the depression point, before inserting it in the tube.

Fourth Series, Hydrogen gas.

	$t$	$t'$	$d$	$h$	$D$	$d \div D$
13. Full draft,....	86.7	58.5	28.2	0	34.2	.82
14. Ditto, .....	85.0	57.4	27.6	0	33.4	.83
15. Ditto, .....	82.8	56.5	26.3	0	32.2	.81

This fourth series, on which every care was bestowed to ensure accuracy, confirming as it does the ratio of the prior experiments, certainly tends to prove that hydrogen produces a less depression than common air in the proportion of 82 to 100; and consequently that the specific heat of this gas for equal volumes should be 1.22, that of atmospheric air being 1.

TAB. XI.—*Depressions with Carbonic Acid.*

	Temp. air. <i>t</i>	Wet- bulb. <i>t'</i>	Depres- sion. <i>d</i>	Hair hygr.	Tabular depression for dry air. <i>D</i>	Ratio. <i>d</i> <i>D</i>
1. Current through steam pipe, ..	91.7	66.2	25.5	(acquired moisture .20 ?)	36.3	?
2. Do. steam on,	161.0	85.0	76.0	Nearly dry ?	82.2	.94
3. Do. quicker draft,	160.0	81.5	78.5	ditto,	81.5	
4. Common air, ..	86.8	60.8	26.0		34.3	

The experiment with common air shews that the passages still imparted moisture to the amount of full .12, and therefore vitiated the result as with hydrogen. The trial was renewed with the precaution of employing the hair hygrometer.

of employing the hair hygrometer.				<i>h</i>		<i>d</i>	<i>D</i>	$d \div D$
5. Short glass tube,	83.6	55.0	28.6	5	Corrected	30.1	32.6	.92
6. Ditto, .....	86.2	55.2	31.0	3	for dry	32.0	34.0	.94
7. Ditto, .....	83.7	53.6	30.0	3	air or	31.0	32.6	.95
8. Common air,....	88.2	54.5	33.7	3	max. dep.	34.8	35.0	

Here again the depression in carbonic acid gas is proved to be 94 hundredths of that in common air, whence the specific heat of this gas should turn out 1.06, air being 1.00. A third series was taken :

8. Well dried, ..	88.7	56.2	32.5	0	32.5	35.3	91
9. Ditto, .....	84.8	55.1	29.7	0.5	29.9	33.2	90
10. Ditto, .....	89.6	57.2	32.4	1	32.8	35.8	90

In the last three experiments which were made with the precautions I have described, in the hydrogen experiments, (13-15) a little of the latter gas was mixed ( $\frac{1}{20}$ th) with the carbonic acid; while in experiments 6, 7, common air may have been present to the same extent. We may therefore assume the maximum depression in dry carbonic acid to be about 92 per cent. of that in atmospheric air; and its spec. heat = 1.087.

Although these unexpected results are supported by their great uniformity, I still feel hesitation in inviting for them the implicit confidence of chemists, in opposition to the very opposite conclusions of other experimenters. Had the specific heat of one gas proved in *defect* and the other in *excess*, it would have been more consonant with the analogy of their specific gravity,—but that two gases so strongly contrasted, should both err, on the same side, I own to be plausible evidence against me. Still I hardly think that the 8 per cent. discrepancy in the carbonic acid experiments is within the limits of experimental error; and the 18 per cent. of the hydrogen is certainly more than I am willing to allow to be attributable to such a cause.

At any rate it must be conceded that the method itself possesses superior facility to the process of DE LA ROCHE and BERARD\*, also followed by HAYCRAFT†, or to that more recently followed by my friends Messrs. F. MARCET and DE LA RIVE of Geneva‡.

It may be as well to recite the conflicting values arrived at by these and other authors, including M. DULONG§, whose mode of investigation by the velocity of sonorous vibrations in the respective gases, was most ingenious in itself, and perhaps better entitled to respect than any other.

TAB. XII.—*Specific heat of gaseous bodies by volume, under constant pressure.*

	By De la Roche and Berard.	By Haycraft	By Marcet and De la Rive.	By DuLong	By wet-bulb depression.
Atmospheric air,	1,000	1,000	1,000	1,000	1,000
Oxygen, . . . . .	976	1,000	1,000	1,000	—
Hydrogen, . . . .	903	1,000	1,000	1,000	1,220
Nitrogen, . . . . .	1,000	1,000	1,000	1,000	—
Carbonic Acid, . .	1,258	1,000	1,000	1,175	1,087
Carburett. Hyd.	1,553	1,060	1,000	1,531	—
Carbonic oxide,	1,034	—	1,000	1,000	—
Nitrous gas, ..	1,350	—	1,000	1,160	—

Notwithstanding the tendency of my own experiments, every one must feel a prejudice on a view of this table in favor of the conclusions of the English and the Genevese philosophers; namely, that all the gases have the same specific heat.

In such case however it will be necessary to assign some other cause for the indubitable results above given, or our judgment must be suspended, until a careful repetition of similar experiments may determine the conditions with other gases, and lead to some definite conclusions for the whole of this most interesting question.

#### § 5.—*A few illustrations of the wet-bulb theory.*

My paper has expanded to such a formidable length, that I am loath to burthen it with many “last words:” yet I cannot refrain from pointing out an instance or two of practical application, and shewing that *d* and *f* are as important elements in the play of meteorological phenomena as the dew-point itself, and require equally to be studied by naturalists.

1. The Baron HUGEL remarked, that ice was formed in Cashmír with the thermometer at 44°|| at an elevation of 15,000 feet: whence he concluded that the freezing point rose as the boiling point fell. This startling paradox is now readily explained: the air of the plains is dry enough at all times in those latitudes:—it becomes relatively drier in expanding on the mountains, while the depression simultaneously

\* Annales de Chimie, lxxxv. 126.

† Annales de Chimie, xxvi. 298.

‡ Ditto 1829. xxxv. 5.

§ Ditto, xli. 113.

|| See J. A. S. vol. v. p. 186.

increases. When  $t = 44^\circ$ ,  $D = 15.5$  which  $+ .27 \left( \frac{d}{16.8} - d \right)$  for 15,000 feet,  $= 18.5$ , so that if the air were already charged with a third of its saturating quantity of vapour, the depression of 13 degrees would still cool a surface of water below the freezing point.

GAY LUSSAC points out a similar fact noted on SAUSSURE's ascent of Mont Blanc. "En faisant tourner sur le *Col du géant* un thermomètre dont la boule était enveloppée d'une éponge, il a obtenu un refroidissement de  $9^\circ.3$  C ( $16^\circ.7$  Farh.) au dessous de la température de l'air qui était de  $10^\circ.1$  ( $50^\circ.2$  F.) ainsi l'évaporation peut concourir avec le rayonnement pour déterminer la congélation de l'eau à la surface de la terre, dans un air dont la température serait de plusieurs degrés au-dessus de zéro\*."

2. The formation of hail is readily explained on the same principle. The drops of water passing through a stratum of very attenuated dry air, perhaps even warmer than the saturated cloud they have quitted, are cooled to congelation—nay, most likely much below it, since they are not remelted in their onward progress to the earth, but are apparently enlarged by deposition of fresh moisture. Hail is seldom observed to fall in damp weather.

Thus also, frozen clouds (cirri) may be found at elevations in the air much lower than would belong by theory to a temperature of  $32^\circ$ , and their dissipation while still in a frozen state, is also accounted for.

3. The increase of rain drops as they approach the earth has been satisfactorily proved to originate in the deposit of atmospheric moisture on their surface, cooled below the dew-point temperature.

4. Why is not the air at sea always surcharged with moisture?

The actual tension of vapour in the air does not depend on  $t$  but  $t'$ : now the bulk of the ocean maintains an uniform temperature, in general a few degrees below that of the air in the day time:  $f'$  therefore being then always less than  $f$ , saturation cannot take place, however much water may be present. But there is another reason; salt-water has a lower tension than pure water; that is, were it heated to  $t$ , its tension would not be  $f$ . It boils at  $213\frac{1}{2}^\circ$  (?) in lieu of  $212^\circ$ , which reduces its tension about one part in 40—and the same proportion will hold good, on DALTON's hypothesis, for lower temperatures. In clear nights the air on ship board must always be fully charged with moisture, and hence the heavy dew on deck.

5. An analogous explanation can be given of the curious fact observed by M. CLEMENT in 1821†, that if a thermometer bulb coated with lint be dipped in a saturated solution of any salt (or the salt in powder) and be held in aqueous vapour of  $212^\circ$ , it will acquire itself

\* Annales de Chimie, xxi. 92.

† URE's Chemical Dictionary, p. 284.

a *higher* temperature, equal to what would be the boiling point of a similar solution. Here the saline solution at  $212^{\circ}$  cannot support a tension of  $f'$  ( $= 30$  in.) ; deposition therefore takes place with consequent disengagement of latent heat, until the tension of the salt at  $t + x$  finds itself in equilibrio, or  $= 30$  inches\*.

6. PERKINS has observed, that when water is thrown upon a heated metal not visibly red, it *flashes* into steam suddenly : but when placed upon iron, silver or gold at a much higher heat, it takes a considerable time to evaporate. Here would seem to be an indication that at or about 1200 Farh. the evaporation point gradually rises to exactly  $212^{\circ}$ , and that beyond this it becomes negative, or, the depression becomes so great that it falls below the boiling point†.

This is surely a more rational explanation than PERKINS's, who supposed the liquid to be prevented from evaporating from the enormous pressure on its surface :—how could such a false equilibrium hold with free space around for the vapour to expand into ?

Many other illustrations might be brought forward, but I forbear from exhausting the patience of my readers, and will here conclude with the tables for the depression of the wet-bulb at temperatures from  $30^{\circ}$  to  $180^{\circ}$  under the constant pressure of 30 inches. For other states of the barometer the small table below will be found sufficient, until my friends in Nepál, Dehra Dun, or the Nilgírís may furnish better data for its correction.

TABLE OF MULTIPLIERS, to convert the following Tabular Depressions at 30 inches (1·000) into the depressions at any other pressure of the atmosphere.

Barometer inches.	Density of the air. e.	Multiplier $1 + \frac{27}{e-1}$	Barometer inches.	Density of the air. e.	Multiplier $1 + \frac{27}{e-1}$	Barometer inches.	Density of the air. e.	Multiplier $1 + \frac{27}{e-1}$
29·5	1·016	1·004	24·5	1·224	1·060	19·5	1·538	1·145
29·0	1·034	1·009	24·0	1·250	1·067	19·0	1·579	1·156
28·5	1·053	1·014	23·5	1·277	1·075	18·5	1·621	1·168
28·0	1·071	1·019	23·0	1·304	1·082	18·0	1·666	1·180
27·5	1·091	1·025	22·5	1·333	1·090	17·5	1·720	1·194
27·0	1·111	1·030	22·0	1·364	1·098	17·0	1·765	1·206
26·5	1·132	1·036	21·5	1·395	1·107	16·5	1·818	1·221
26·0	1·154	1·042	21·0	1·428	1·115	16·0	1·875	1·236
25·5	1·176	1·048	20·5	1·463	1·125	15·5	1·935	1·252
25·0	1·200	1·054	20·0	1·500	1·135	15·0	2·000	1·270

NOTE.—When the depression in attenuated air has been observed, *divide* it by the multipliers here given, before entering the table following to find the aqueous tension.

\* A new source of error in the wet-bulb is hence suggested, in the substance with which the bulb is coated :—flannel, linen, and cotton may have different hygrometric affections. This is a fit subject for inquiry.

† The very slight modification required in the theoretical curve of depressions, to produce the effect alluded to in the text, is shewn by a dotted line in Fig. 5 of Pl. XXI. APJOHN's temperature of evaporation only reaches  $212^{\circ}$  at  $2800^{\circ}$ . LESLIE's at  $2600^{\circ}$  ; beyond which it would continue to rise.

TABLE of the DEPRESSIONS of the Wet-bulb Thermometer, for degrees of temperature, and every twentieth part of hygrometric saturation.

Temperature.	The centesimal tension of vapour, or percentage of humidity being																			95
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	10.6	9.2	8.3	7.6	6.9	6.4	5.8	5.3	4.8	4.4	4.0	3.5	3.1	2.6	2.3	1.9	1.6	1.1	0.7	0.3
31	10.9	9.4	8.5	7.8	7.1	6.5	6.0	5.4	5.0	4.5	4.1	3.6	3.2	2.8	2.3	1.9	1.6	1.1	0.7	0.4
32	11.2	9.7	8.8	8.0	7.3	6.7	6.2	5.6	5.1	4.6	4.2	3.7	3.3	2.8	2.4	2.0	1.6	1.1	0.8	0.4
33	11.5	10.0	9.8	8.2	7.5	6.9	6.3	5.7	5.3	4.8	4.3	3.8	3.4	2.9	2.5	2.0	1.7	1.1	0.8	0.4
34	11.8	10.2	9.2	8.4	7.7	7.1	6.5	5.9	5.4	4.9	4.4	3.9	3.5	3.0	2.5	2.1	1.7	1.2	0.8	0.4
35	12.1	10.5	9.5	8.7	7.9	7.3	6.6	6.0	5.5	5.0	4.5	4.0	3.5	3.1	2.6	2.1	1.8	1.2	0.8	0.4
36	12.4	10.8	9.7	8.9	8.1	7.4	6.8	6.2	5.7	5.1	4.6	4.1	3.6	3.2	2.7	2.2	1.8	1.2	0.8	0.4
37	12.7	11.0	9.9	9.1	8.3	7.6	7.0	6.3	5.8	5.3	4.7	4.2	3.7	3.2	2.7	2.2	1.9	1.3	0.9	0.4
38	13.0	11.3	10.2	9.3	8.5	7.8	7.1	6.5	5.9	5.4	4.9	4.3	3.8	3.3	2.8	2.3	1.9	1.3	0.9	0.4
39	13.3	11.5	10.4	9.5	8.7	8.0	7.3	6.6	6.1	5.5	5.0	4.4	3.9	3.4	2.9	2.3	1.9	1.3	0.9	0.4
40	13.6	11.8	10.6	9.7	8.9	8.1	7.5	6.8	6.2	5.6	5.1	4.5	4.0	3.5	2.9	2.4	2.0	1.4	0.9	0.4
41	13.9	12.0	10.9	9.9	9.1	8.3	7.6	7.0	6.4	5.8	5.2	4.6	4.1	3.5	3.0	2.5	2.0	1.4	0.9	0.4
42	14.2	12.3	11.1	10.2	9.3	8.5	7.8	7.1	6.5	5.9	5.3	4.7	4.2	3.6	3.1	2.5	2.1	1.4	1.0	0.5
43	14.6	12.6	11.4	10.4	9.6	8.8	8.0	7.3	6.7	6.0	5.4	4.8	4.3	3.7	3.1	2.6	2.1	1.5	1.0	0.5
44	14.9	12.9	11.6	10.7	9.8	8.9	8.2	7.5	6.8	6.2	5.6	5.0	4.4	3.8	3.2	2.6	2.2	1.5	1.0	0.5
45	15.3	13.3	11.9	10.9	10.0	9.2	8.4	7.7	7.0	6.3	5.7	5.1	4.5	3.9	3.3	2.7	2.2	1.5	1.0	0.5
46	15.6	13.5	12.2	11.2	10.2	9.4	8.6	7.8	7.1	6.5	5.8	5.2	4.6	4.0	3.4	2.8	2.3	1.6	1.1	0.5
47	16.0	13.9	12.5	11.4	10.5	9.6	8.8	8.0	7.3	6.6	6.0	5.3	4.7	4.1	3.4	2.8	2.3	1.6	1.1	0.5
48	16.3	14.1	12.7	11.7	10.7	9.8	9.0	8.2	7.5	6.8	6.1	5.4	4.8	4.1	3.5	2.9	2.4	1.6	1.1	0.5
49	16.7	14.5	13.0	11.9	10.9	10.0	9.2	8.4	7.6	6.9	6.2	5.6	4.9	4.2	3.6	2.9	2.4	1.7	1.1	0.5
50	17.1	14.8	13.3	12.2	11.2	10.3	9.4	8.6	7.8	7.1	6.4	5.7	5.0	4.4	3.7	3.0	2.5	1.8	1.2	0.6
51	17.5	15.2	13.7	12.5	11.5	10.5	9.6	8.8	8.0	7.3	6.5	5.8	5.1	4.5	3.8	3.1	2.5	1.8	1.2	0.6
52	17.9	15.5	14.0	12.8	11.7	10.7	9.8	9.0	8.2	7.4	6.7	6.0	5.3	4.6	3.9	3.2	2.6	1.8	1.2	0.6
53	18.3	15.9	14.3	13.1	12.0	11.0	10.1	9.2	8.4	7.6	6.8	6.1	5.4	4.7	3.9	3.2	2.6	1.9	1.2	0.6
54	18.7	16.2	14.6	13.4	12.3	11.2	10.3	9.4	8.6	7.8	7.0	6.3	5.5	4.8	4.0	3.3	2.7	1.9	1.3	0.6
55	19.1	16.5	14.9	13.7	12.5	11.5	10.5	9.6	8.7	7.9	7.1	6.4	5.6	4.9	4.1	3.4	2.7	1.9	1.3	0.6
56	19.6	17.0	15.3	14.0	12.8	11.8	10.8	9.8	9.0	8.1	7.3	6.5	5.8	5.0	4.2	3.5	2.8	2.0	1.3	0.6
57	20.0	17.3	15.6	14.3	13.1	12.0	11.0	10.0	9.2	8.3	7.5	6.6	5.9	5.1	4.3	3.5	2.9	2.0	1.4	0.7
58	20.4	17.7	15.9	14.6	13.4	12.2	11.2	10.2	9.3	8.5	7.6	6.8	6.0	5.2	4.4	3.6	2.9	2.1	1.4	0.7
59	20.8	18.0	16.2	14.9	13.6	12.5	11.4	10.4	9.5	8.6	7.8	6.9	6.1	5.3	4.5	3.7	3.0	2.1	1.4	0.7
60	21.3	18.5	16.6	15.2	14.0	12.8	11.7	10.7	9.7	8.8	8.0	7.1	6.3	5.4	4.6	3.8	3.1	2.2	1.4	0.7

TABLE of the DEPRESSIONS of a Wet-bulb Thermometer, for degrees of temperature, and every twentieth part of hygrometric saturation.

Tempe- rature.	The centesimal tension of vapour, or percentage of humidity being																			95
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
61	21.7	18.8	16.9	15.5	14.2	13.0	11.9	10.9	9.9	9.0	8.1	7.2	6.4	5.5	4.7	3.8	3.1	2.2	1.5	0
62	22.2	19.2	17.3	15.9	14.6	13.3	12.2	11.1	10.2	9.2	8.3	7.4	6.5	5.7	4.8	3.9	3.2	2.3	1.5	0.7
63	22.6	19.6	17.6	16.2	14.8	13.6	12.4	11.3	10.3	9.4	8.4	7.5	6.6	5.8	4.8	4.0	3.2	2.3	1.5	0.7
64	23.1	20.0	18.0	16.5	15.1	13.9	12.7	11.6	10.6	9.6	8.6	7.7	6.8	5.9	4.9	4.1	3.3	2.4	1.6	0.8
65	23.5	20.4	18.4	16.8	15.4	14.1	12.9	11.8	10.8	9.7	8.8	7.8	6.9	6.0	5.0	4.1	3.4	2.4	1.6	0.8
66	24.0	20.8	18.7	17.2	15.7	14.4	13.2	12.0	11.0	10.0	9.0	8.0	7.0	6.1	5.1	4.2	3.4	2.4	1.6	0.8
67	24.4	21.1	19.1	17.5	16.0	14.6	13.4	12.2	11.2	10.1	9.1	8.1	7.2	6.2	5.2	4.3	3.5	2.5	1.7	0.8
68	24.9	21.6	19.4	17.8	16.3	14.9	13.7	12.5	11.4	10.3	9.3	8.3	7.3	6.3	5.3	4.4	3.6	2.5	1.7	0.8
69	25.4	22.0	19.8	18.1	16.7	15.2	14.0	12.7	11.6	10.5	9.5	8.4	7.5	6.5	5.4	4.5	3.6	2.6	1.7	0.8
70	25.9	22.4	20.2	18.5	17.0	15.5	14.2	13.0	11.9	10.7	9.7	8.6	7.6	6.6	5.5	4.6	3.7	2.6	1.8	0.8
71	26.4	22.9	20.6	18.8	17.3	15.6	14.5	13.2	12.1	10.9	9.9	8.8	7.8	6.8	5.7	4.7	3.8	2.7	1.8	0.9
72	26.8	23.2	20.9	19.1	17.6	15.9	14.7	13.4	12.3	11.1	10.0	8.9	7.9	6.8	5.7	4.7	3.8	2.7	1.8	0.9
73	27.3	23.7	21.3	19.5	17.9	16.2	15.0	13.7	12.5	11.3	10.2	9.1	8.0	7.0	5.8	4.8	3.9	2.8	1.9	0.9
74	27.8	24.1	21.7	19.8	18.2	16.5	15.3	13.9	12.7	11.5	10.4	9.3	8.2	7.1	6.0	4.9	4.0	2.8	1.9	0.9
75	28.3	24.5	22.1	20.2	18.6	16.8	15.6	14.2	13.0	11.7	10.6	9.4	8.3	7.2	6.1	5.0	4.0	2.9	1.9	0.9
76	28.8	25.0	22.4	20.5	18.9	17.1	15.8	14.4	13.2	11.9	10.8	9.6	8.5	7.3	6.2	5.1	4.1	2.9	2.0	0.9
77	29.3	25.4	22.8	20.9	19.2	17.4	16.1	14.7	13.4	12.1	10.9	9.7	8.6	7.5	6.3	5.2	4.2	3.0	2.0	1.0
78	29.8	25.8	23.2	21.3	19.5	17.7	16.4	14.9	13.6	12.4	11.1	9.9	8.8	7.6	6.5	5.3	4.2	3.0	2.0	1.0
79	30.3	26.3	23.6	21.6	19.9	18.0	16.7	15.2	13.9	12.6	11.3	10.1	8.9	7.7	6.6	5.4	4.3	3.1	2.1	1.0
80	30.8	26.7	24.0	22.0	20.2	18.3	16.9	15.5	14.1	12.8	11.5	10.3	9.0	7.8	6.6	5.4	4.4	3.1	2.1	1.0
81	31.3	27.1	24.4	22.3	20.5	18.6	17.2	15.7	14.3	13.0	11.7	10.4	9.2	8.0	6.8	5.5	4.5	3.2	2.1	1.0
82	31.8	27.6	24.7	22.7	20.9	18.9	17.5	16.0	14.6	13.2	11.9	10.6	9.3	8.1	6.8	5.6	4.5	3.2	2.2	1.0
83	32.3	28.0	25.1	23.0	21.2	19.2	17.8	16.2	14.8	13.4	12.1	10.8	9.5	8.2	6.9	5.7	4.6	3.3	2.2	1.1
84	32.8	28.4	23.4	23.4	21.5	19.5	18.0	16.5	15.0	13.6	12.3	10.9	9.6	8.4	7.0	5.8	4.7	3.3	2.2	1.1
85	33.3	28.9	23.8	23.8	21.8	19.8	18.3	16.7	15.2	13.8	12.5	11.1	9.8	8.5	7.1	5.9	4.7	3.4	2.3	1.1
86	33.9	29.4	26.4	24.2	22.2	20.7	18.6	17.0	15.5	14.1	12.8	11.3	10.0	8.6	7.3	6.0	4.8	3.5	2.3	1.1
87	34.4	29.8	26.8	24.5	22.6	21.0	18.9	17.3	15.7	14.3	13.0	11.5	10.1	8.8	7.4	6.1	4.9	3.5	2.3	1.1
88	34.9	30.2	27.1	24.9	22.9	21.3	19.2	17.5	16.0	14.5	13.1	11.6	10.3	8.9	7.5	6.2	5.0	3.6	2.4	1.1
89	35.4	30.7	27.6	25.3	23.2	21.6	19.5	17.8	16.2	14.7	13.3	11.8	10.4	9.0	7.6	6.3	5.0	3.6	2.4	1.1
90	36.0	31.2	28.0	25.7	23.6	22.0	19.8	18.1	16.5	14.9	13.6	12.0	10.6	9.2	7.7	6.4	5.1	3.7	2.4	1.2
91	36.5	31.6	28.4	26.1	23.9	22.3	20.1	18.3	16.7	15.1	13.7	12.2	10.7	9.3	7.8	6.5	5.2	3.7	2.5	1.2

TABLE of the DEPRESSIONS of a Wet-bulb Thermometer, for degrees of temperature, and every twentieth part of hygrometric saturation.

Tempe- rature.	The centesimal tension of vapour, or percentage of humidity being																			
	0	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	95
92	37.1	32.1	28.9	26.5	24.3	22.7	20.4	18.6	17.0	15.4	14.0	12.3	10.8	9.5	8.0	6.6	5.3	3.8	2.5	0
93	37.6	32.5	29.3	26.8	24.7	23.0	20.7	18.9	17.2	15.6	14.2	12.5	10.9	9.6	8.1	6.6	5.3	3.8	2.6	1.2
94	38.2	33.0	29.8	27.3	25.0	23.3	21.0	19.2	17.5	15.8	14.4	12.7	11.1	9.7	8.2	6.8	5.4	3.9	2.6	1.3
95	38.7	33.5	30.2	27.6	25.4	23.6	21.3	19.4	17.7	16.1	14.6	12.9	11.5	9.9	8.3	6.8	5.5	4.0	2.6	1.3
96	39.3	34.1	30.8	28.1	25.8	23.6	21.6	19.7	18.1	16.3	14.7	13.1	11.5	10.0	8.7	6.9	5.5	4.0	2.7	1.3
97	39.8	34.5	31.2	28.5	26.1	23.9	21.9	20.0	18.3	16.5	14.9	13.3	11.7	10.1	8.8	7.0	5.6	4.1	2.7	1.3
98	40.4	35.0	31.6	28.9	26.5	24.2	22.2	20.3	18.6	16.8	15.1	13.5	11.9	10.3	8.9	7.1	5.6	4.7	2.7	1.3
99	41.0	35.5	32.1	29.3	26.9	24.6	22.5	20.6	18.9	17.0	15.3	13.7	12.0	10.4	9.0	7.2	5.7	4.8	2.8	1.3
100	41.6	36.1	32.6	30.8	27.3	25.0	22.9	20.6	18.6	17.3	15.5	13.9	12.2	10.6	9.2	7.4	5.8	4.8	2.8	1.4
101	42.2	36.6	33.0	40.2	27.7	25.3	23.2	20.9	18.4	17.5	15.8	14.1	12.4	10.8	9.3	7.5	5.9	4.9	2.9	1.4
102	42.8	37.1	33.5	40.6	28.1	25.7	23.5	21.5	18.7	17.8	16.0	14.3	12.6	10.9	9.4	7.6	6.0	5.0	2.9	1.4
103	43.4	37.6	34.0	41.1	28.5	26.0	23.9	21.8	17.0	18.0	16.2	14.5	12.7	11.1	9.6	7.7	6.1	5.0	2.9	1.4
104	44.0	38.1	34.4	41.5	28.9	26.4	24.2	22.1	17.3	18.3	16.4	14.7	12.9	11.2	9.7	7.8	6.2	5.1	3.0	1.4
105	44.6	38.7	35.0	41.9	29.2	26.8	24.5	22.4	17.5	18.5	16.7	14.9	13.0	11.4	9.8	7.9	6.2	5.1	3.0	1.5
106	45.2	39.2	35.4	42.4	29.6	27.1	24.9	22.7	17.8	18.8	16.9	15.1	13.2	11.5	10.0	8.0	6.3	5.2	3.1	1.5
107	45.8	39.7	35.9	42.8	30.0	27.5	25.2	23.0	18.1	19.0	17.1	15.3	13.4	11.7	10.1	8.1	6.4	5.3	3.1	1.5
108	46.4	40.2	36.3	43.2	30.4	27.8	25.5	23.3	18.4	19.3	17.3	15.5	13.5	11.8	10.2	8.2	6.5	5.3	3.1	1.5
109	47.0	40.7	36.8	43.6	30.8	28.2	25.8	23.6	18.6	19.5	17.6	15.7	13.7	12.0	10.3	8.3	6.6	5.4	3.2	1.5
110	47.6	41.3	37.3	44.1	31.2	28.6	26.2	23.9	18.9	19.8	17.8	15.9	13.9	12.1	10.5	8.4	6.7	5.4	3.2	1.6
120	53.9	46.7	42.2	48.6	35.3	32.3	29.6	27.0	21.8	22.4	20.1	18.0	15.7	13.7	11.8	9.5	7.5	6.1	3.7	1.8
130	60.5	52.4	47.4	53.3	39.7	36.3	33.3	30.4	24.8	25.1	22.6	20.2	17.7	15.4	13.3	10.7	8.5	6.8	4.1	2.0
140	67.3	58.3	52.7	58.2	44.1	40.4	37.0	33.8	27.9	27.9	25.2	22.5	19.7	17.2	14.7	11.9	9.4	7.5	4.6	2.2
150	74.3	64.4	58.2	63.2	48.7	44.6	40.1	37.3	31.1	30.8	27.8	24.8	21.7	18.9	16.2	13.1	10.4	8.2	5.0	2.4
160	81.5	70.7	63.8	68.3	53.5	48.9	44.8	40.9	34.4	33.8	30.5	27.2	23.9	20.8	17.8	14.4	11.4	8.9	5.5	2.7
170	88.9	77.1	69.6	73.6	58.3	53.3	52.9	44.6	37.8	36.9	33.2	29.7	26.0	22.7	19.4	15.7	12.4	9.7	6.0	2.9
180	96.5	83.7	75.5	79.1	63.3	57.9	57.1	48.4	41.3	40.9	36.1	32.2	28.3	24.6	21.0	17.1	13.5	10.5	6.6	3.2
184	100.0	86.7	78.3	71.6	65.6	60.0	55.0	50.2	45.8	41.5	37.4	33.4	29.4	25.5	21.6	17.7	14.0	10.3	6.8	3.3

To find the real quantity of moisture in the air, the centesimal tension deduced from this table must be multiplied into the aqueous tension for the given temperature, extracted from DALTON'S, Biot's, or URE'S tables.

VI.—*Proceedings of the Asiatic Society.**Wednesday Evening, 3rd August, 1836.*

The Honorable Sir EDWARD RYAN, President, in the chair.

Mr. W. SPIERS, proposed at the last meeting, was ballotted for, and duly elected a Member of the Society.

Mr. Conductor DAWE, of the Delhi Canal Establishment, proposed at the last meeting, was, upon the favorable report of the Committee of Papers, elected an associate member.

MEKHARA MENG, uncle of the present King of Ava, acknowledged his election as an honorary member in a Bengálí letter, of which the following is a literal translation :—

MEKHARA RA'JA to the learned Members of the Asiatic Society of Calcutta, commands.

I am informed of the contents of the letter from this learned body, and of the honor they have done to me. But so difficult is the attainment of knowledge, that I can by no means hold myself worthy of such a distinction. The progress of knowledge may be likened to the ascent of a lofty mountain,—he that attains the summit will gain the first glimpse of the rising sun, then he in the centre, while yet it is hidden from the crowd at the base. The sun is to them a thing entirely imperceptible. Afterwards, when the solar orb declines, it still remains visible and palpable to him who has surmounted the hill, while the others have a partial and fading remembrance of its glory. Thus are there gradations in the acquirement and appreciation of learning, and there is no limit to its increase, nor can any thing compare with its excellence.

The enjoyments of worldly life are finite, and afford little variety—riches bring satiety; but there is no satiety in knowledge. Every day brings novel food to the mind, and only whets the appetite for more. I do not then think myself learned, but it is a law of nature that the bulk of each species should remain on an equality, whether man, beast, reptile, tree, or land itself—and hold social commune with its fellows.

My name has been inserted in the list of the learned men—I am glad to hear it, for the mind that cannot traverse alone the field of knowledge; in company of judicious guides, may derive instruction and advantage at every step. I shall know what I have not known—hear what I have not heard. All my doubts may be explained, my conjectures certified :—therefore am I filled with joy, for I would have my ignorance enlightened.

Should the Society wish to know any thing relative to the Burmese literature of my country, I will do my utmost to supply every information.

As the learned members are acquainted with various languages, I have caused this letter to be written in the Pálí language\* and in the Bengálí character.

The Secretary read the following reply from Government to the application made, in conformity with the resolution of the last meeting, on the subject of the publication of the Cochin Chinese Dictionary.

TO JAMES PRINSEP, ESQ.

Genl. Dept.

Secretary to the Asiatic Society.

SIR,

I am directed to acknowledge the receipt of your letter, dated the 11th instant, and in reply to state that the Right Honorable the Governor General of India in Council will be prepared to sanction an expense of 5,500 rupees to be incurred in printing a Cochin Chinese Dictionary by Lithography in the manner

\* The letter contains an admixture of Pálí words, but the substance is in Bengálí, and is evidently a very imperfect rendering of the author's expressions by a Bengálí writer.

proposed by the author; but his Lordship would prefer much, that in order to make the work accessible to seafaring persons and traders as well as to the learned, the explanation should be given in English as well as in Latin, and that a Vocabulary rendering the common English words into Cochin Chinese should be added to the volume.

2. His Lordship would hope that by compressing the writing in the page which is rather wide in the specimens transmitted, these additions could be brought nearly within the same compass so as to occasion very little additional expense.

3. The specimen which accompanied your letter is herewith returned.

I am, &c.

H. T. PRINSEP,

*Secy. to Govt.*

*Council Chamber, the 20th July, 1836.*

In consequence of the above suggestions, the Secretary had, in consultation with the author, returned the following reply:—

TO H. T. PRINSEP, Esq.

*Secretary to the Government of India, Genl. Dept.*

SIR,

I have the honor to acknowledge the receipt of your letter, dated the 20th July last, communicating the acquiescence of the Right Honorable the Governor General of India in Council to the proposition submitted by myself, on the part of the Asiatic Society, and of the most Rev. the Bishop of Isauropolis, for the publication of a Cochin Chinese Dictionary in lithography at an expense not exceeding 5,500 rupees.

I have accordingly placed myself in communication with the author, with a view to arrange the preliminaries without loss of time, as well as to provide for the modifications recommended by his Lordship in Council.

The Bishop is of opinion that the addition of a column of English meanings to the Dictionary in its present form would involve a very serious increase of labour in passing it through the press; it would also augment the bulk of the work very considerably; while a very large portion of the words and explanations connected with literary and abstract terms would be of no utility whatever to the commercial class or to seafaring persons.

The object contemplated by his Lordship in Council may, he thinks, be supplied with more facility by the addition of a Supplementary Vocabulary containing all the most common words, which might also be published in a detached form for the use of mariners and traders.

This Vocabulary the author undertakes to draw up in the English, French, and Anamitan tongues, during the progress of the publication; and precaution has been taken to include this additional matter in the estimates which have been called for.

His Lordship's remarks on the appearance of the lithographed specimen, and the obvious advantage, if possible, of securing to a standard work of this nature the advantages and neatness of typography, induced me to communicate again with the Proprietors of the Serampore Press, before any final arrangements should be made.

The Bishop on his own part handsomely consented to relinquish 500 rupees out of the 4,000 rupees of personal remuneration for which he had at first stipulated. I was thus enabled to offer a clear sum of 2,000 rupees to Rev. Dr. MARSHMAN for the execution of 500 copies of a quarto volume, containing nearly 500 pages, with the native words in the Cochin-Chinese character. This offer, although much below the usual Calcutta printing rates for ordinary works, has been in the most liberal manner accepted by the Rev. Dr. and Mr. J. MARSHMAN.

I now therefore only wait for the final sanction of Government to place the MSS. &c. in their hands.

I am, &c.

(Signed) JAMES PRINSEP,

*Secy.*

*Calcutta, 1st August, 1836.*

To this letter the following reply had just been received :—

TO JAMES PRINSEP, ESQ.

*Secretary to the Asiatic Society.*

SIR,

I am directed by the Right Honorable the Governor General of India in Council to acknowledge the receipt of your letter dated the 1st instant, and in reply to state that his Lordship entirely approves the arrangement made by you on the part of the Asiatic Society for the publication at the Serampore Press of the Anamitan Dictionary prepared by the Most Reverend the Bishop of Isauropolis, at the charge already sanctioned, of 5,500 rupees.

2. The modifications made in the original proposition seem to his Lordship in Council calculated very much to improve the work, and entirely meet the wishes expressed in my letter dated 20th ultimo.

3. The Governor General in Council has much satisfaction in acknowledging the disinterested and public-spirited offer made by the Right Reverend author, to forego a portion of the remuneration allotted to him in order to obtain the advantage of having the work published in type; and the terms accepted by Dr. MARSHMAN of Serampore appear to his Lordship in Council to be not less liberal; for the rate at which they have agreed to print the work in the original character is such as can afford them little or no profit.

4. It is the wish of the Governor General in Council that additional copies should be printed of the Vocabulary proposed to be added; and if this should occasion an increase of expense, his Lordship in Council will have no objection to defray the amount that may be charged on this account, taking for Government an additional 100 copies of this part of the work.

I am, Sir, &c.

*Council Chamber, the 3rd Aug. 1836.*

H. T. PRINSEP,

*Sec. to Govt.*

The liberality of the proprietors of the Serampore Press in undertaking to print the work without any hope of profit, or even at the risk of some sacrifice, was fully appreciated by the Society, and the best thanks of the meeting were conveyed to Dr. MARSHMAN, who was present.

A bill from the Orphan Press for printing the 1st part of the twentieth volume of *Researches*, 248 pages, amounting to C.'s Rs. 1806 6 4, was presented and passed.

#### *Oriental Publications.*

The Secretary reported the completion of the *Naishadha-Cheritra* (1st part, 900 pages) one of the Sanscrit works transferred from the Committee of Public Instruction; of which copies were ready for distribution. By the terms of agreement with the Editor, PREMA CHANDRA PANDITA, of the Calcutta Sanscrit College, who had supplied the *tiká* or commentary, 100 copies were to be given to him in lieu of pecuniary remuneration, which was approved.

#### *Library.*

The following books were presented :—

Results of Astronomical Observations made at the Madras Observatory during the years 1834 and 1835—*presented by the Madras Government, through Colonel Casement, Mil. Sec. Sup. Govt.*

Jahr bucher der Literatur, No. 69, 70, 71, and 72—*presented by the Baron Joseph Von Hammer.*

Notizia di Diciotto Codici Persiani della Biblioteca della Regia Università di Torino—*by the same.*

Memoire sur deux Coffrets Gnostiques du moyen age—*by the same.*

Mamik und Afra, a German Poem, translated from the Persian—*by the same.*

Historical Oriental Translations and Researches, 2 vols. quarto, by the Rev. W. TAYLOR, Madras—*presented by the author.*

Journal of the Royal Asiatic Society of Great Britain and Ireland, No. 4—*by the Society.*

A descriptive and illustrated catalogue of the Physiological Series of Comparative Anatomy, contained in the Museum of the Royal College of Surgeons in London, Vol. III. Part I.—*by the President of the College.*

The Sixth Annual Report of the Society of Natural History of the Mauritius—*by M. Julien Des Jardins, Sec.*

Madras Journal of Literature and Science, No 12, for April and July, 1836—*by the Madras Literary Society.*

The Indian Journal of Medical Science, No. 8, and Review of Works on Science—*by F. Corbyn, Esq. the Editor,*

Meteorological Register for June 1836—*by the Surveyor General.*

The following books were received from the booksellers:—

Lardner's Cabinet Cyclopaedia—Botany, 1 vol.

———, Foreign Statesmen, vol. 2nd.

#### *Museum.*

Read a letter from J. BELL, Esq. Secretary Agricultural and Horticultural Society, forwarding for the acceptance of the Society two blankets and two woollen cloths on behalf of Lieutenant H. VETCH.

The blankets are made from the *Simul* tree; the woollen cloths are of Bho-tian manufacture.

#### *Literary Communications.*

The Government of Madras referred for the consideration of the Society, through the Supreme Government, a proposition submitted by CAVELLY VENKATA LACSHMIA, Pandit, to re-establish the system of Historical Research so successfully pursued by the late Col. COLIN MACKENZIE in the Peninsula, by collecting inscriptions, manuscripts, grants, &c. as well as to translate and digest the mass of materials already collected, and now in the possession of the Royal Asiatic Society.

CAVELLY VENKATA had drawn up a report-progress of the researches, in which he states himself to be still engaged, classifying the different dynasties, ancient and modern, of South India, on which light has been thrown by the Mackenzie collection. This paper and the correspondence were referred to the Committee of Papers for their examination and report, previous to discussion of the question in the Society.

Mr. W. H. MACNAGHTEN presented an elaborate Memoir by Lieut.-Colonel BURNEY, Resident in Ava, entitled "An account of the wars between Burmah and China, together with the journals and routes of three different embassies sent to Peking by the king of Ava, taken from Burmese documents.

[Referred to the Committee of Papers. This account has peculiar interest at the present moment, when the offer of Mr. GUTZLAFF to penetrate through China to Ava or Assam has been much discussed.]

Mr. TREVELYAN on behalf of M. C. MASSON presented a third memoir on the coins discovered at Beghrum.

This paper is a careful and laborious recapitulation of all that has been done in this curious branch of discovery, with the addition of the results of a third year's search. The acquisition of new coins and new names naturally becomes every day more rare; so that notwithstanding the addition of 2,294 coins to his

cabinet in the year 1835, the only real novelties are an unique coin of ARCHELIUS, one of DIOMEDES (found in 1834) the confirmation of ADELPHORTOS and IPALIRISUS. Three Euthydemus', and one Antiochus have been gained; the ratio of the more common Bactrian and Indo-Scythic names is much the same as in former years. We shall hasten to publish such portions of M. MASSON'S most industrious labours as have not hitherto appeared in our pages.

Mr. AVDALL brought to the Society's attention a singular narrative, in translation, of the interview between ARSACES, king of Armenia, and the Persian Monarch SAPOR (ALAKNAF.)

[We hope to find room for this curious morceau ere long.]

The Secretary read extract of a letter from the Counsellor JOSEPH VON HAMMER, of Vienna, (now Baron PURGSTALL,) forwarding a continuation of his translation of the *Mohit*, an Arabic nautical work by SIDI CAPUDAN, of which the first chapter was printed in the third volume of the Journal.

The present chapter contains a catalogue of the islands along the shores of the Red Sea, and directions for thirty different voyages from Loheia, Aden, &c. to the various ports of India, Persia, and the Straits of Malacca. It is a fact difficult to be accounted for, that the learned author offered to translate the whole of this very scarce and curious work for the Oriental Translation Committee, who have given to the world so many of less consideration; but he was not honored with a reply.

Extracts were also read from other European Correspondence. Professor WILSON reports his having forwarded the Society's memorial regarding Oriental publications to the Royal Asiatic Society, which, in concurrence with the Oriental Translation Committee, had warmly espoused the object of its prayer. The Foreign Societies had also supported it, as far as the voice of protestation and argument by a body of the most distinguished oriental scholars can lend its influence.

Paris has set a further example which it would be unjust to the cause to omit mentioning.

Colonel TROYER, having presented to the Société Asiatique a German translation of the first six books of the *Rāj Tarangini*, (one of the Sanscrit works suspended by the Government order, and lately completed by the Society here,) was invited to undertake a French version of the same for publication *with the Sanscrit text* at the Society's expence, estimated at not less than 6,000 francs. It may be hoped that the edition completed in India, of which specimens must soon after have reached Paris, will spare a portion of this money for the many other objects embraced by this active association.

M. JACQUET announces the contemplated institution of a new professorship of the Oriental languages in the University of Ghent, which well desire to accumulate manuscripts and printed works from this country. The late discovery of coins and inscriptions in India had excited the most intense interest on the Continent, but General VENTURA'S collection had not yet reached Paris, on account of the detention of General ALLARD by illness in the South of France.

With regard to the coins of the Kadphises group, M. JACQUET having seen HONIGBERGER'S collection would read the name *Mokadphises*, which he suggests to be *Mahátricha* of the Sanscrit. We await his papers on this subject in the *Journal Asiatique*.

#### Physical.

A collection of specimens made by Captain HANNAY in his recent expedition up the Irawadí to the Amber mines, was presented by Colonel BURNEY.

The collection includes many varieties of white and gray marble—serpentine, agates, jaspers, heliotrope and crystal, particularly a pale

green prase, much prized by the Chinese, and called by them *Yu*; it is found about 80 miles N. W. of Mogaung. Wrist rings are cut from it.

With the specimens was a substance called by the Burmese *earth wax*, which they say exudes from some high precipitous rocks above Ava. They add, that monkeys are particularly fond of this substance, and that those animals swarm about the rocks which yield it. The wax has all the appearance of common unbleached wax.

There was also a specimen of the tea prepared by the Singphos of Payendwen; and a poisonous plant used by the Mishmís, supposed by Dr. WALLICH to be identical with the *Bish* of the Gurkhas, (*Aconitum*;) another herb *myenthé*, used by the Mishmis for the same purpose, had more the appearance of an Acanthaceous plant.

The fossil bones from Perim in the Cambay Gulph, presented by the Baron HUGEL, had arrived. Among them is a large and indisputable fragment of a buffalo's horn, which the Baron refers with probability to the Nerbudda fossil bos; two smaller horns imbedded in matrix, (a calcareous and ferruginous conglomerate.) Also shells from a similar conglomerate in Gogo, and specimens of the cornelian, natural and burned, from the *Ratanpur* quarries.

A geological series from Pulos Floer, Trotto, Ledah, Tingy, Pigeon Island, Birdnest Island, and Dehli point, in the Straits of Malacca, was presented by Dr. BLAND, of H. M. S. *Wolf*, with a note of their locality, and some remarks on the genus of shells denominated *Pterocyclos* by BENSON (*Spiraculum* by PEARSON), found in abundance on the islet of Susson, opposite Queda Peak.

[Dr. BLAND's notes shall have early insertion.]

Specimens of a calcareous and silicious Scoria, forming the substance of a small hill at *Bádígúnta* near Courtney, about 11 miles west of Bellary, was presented by Lieut. NEWBOLD.

[The accompanying note will be inserted.]

Mr. C. W. SMITH having purchased a collection of specimens of Natural History from the Eastern Isles, presented the Mammalia, the duplicates of the Birds and the Reptiles, to the Museum, on condition of the remaining birds being mounted for him. The Mammalia and Reptiles consist of the following specimens:—The grey Roussette, (*Pteropus Griseus*) two specimens; one of a species of *Noctilionina*, and one of *Vespertilionina*, probably new genera; one of a species of Marten, agreeing in specific characters very exactly with the Pine Marten, (*Martes Vulgaris*;) two young specimens of a species of Ictus; one of the Barang Otter, (*Lutra Lutreola*?) one of the slender Delundung, (*Prionodon Gracilis*;) one of the Sumatra Cat, (*Felis Sumatrana*;) one of the Madagascar Squirrel, (*Sciurus Madagascariensis*;) one of the Jeralang, (*Sciurus Leschenaultii*;) two of the two-banded Squirrel, (*S. Bivittatus*;) and two specimens of the Java Musk Deer, (*Moschus Javanicus*.) The Reptiles are a specimen of the Eastern Box Terrapia, (*Cistuda Amboinensis*;) and one of the Clouded Monitor of GRAY's Synopsis, (*Monitor Nebulosus*.)

A specimen of Bengal Vulture, (*Vultur Bengalensis*), presented by Major FANE.

The specimens of birds presented at the last meeting were exhibited, having been mounted in the Museum.

*Physical Communications.*

A memoir on the Fossil Rhinoceros of the sub-Himálayas, was forwarded by Lieuts. BAKER and DURAND, of the Engineers.

[This, with the lithographs and engravings kindly prepared by the authors themselves for the Journal, will be published in the ensuing number.]

Mr. HODGSON, of Nepál, continued his contributions of new species in two papers: 1, on the thick-billed finches; 2, on two genera of Columbidæ. Twenty-two ornithological plates were also added to the magnificent series of illustrations now under dispatch home.

A note on nest of the Bengal Vulture was submitted by Lieutenant HUTTON.

A Register of Rain at Delhi, by the Rev. R. EVEREST.

A living specimen of the new genus of venomous snakes denominated *Hamadryas* by Dr. CANTOR, was exhibited to the Society; it measured nearly 10 feet in length, and was caught in the *Sundarbans*.

VII.—*Miscellanea.*

*Madras Journal of Literature and Science.*—It has not been hitherto our custom to enter into criticism of the contents of contemporary journals, but we cannot refrain from noticing the number issued by our sister society of Madras in July, which has just reached us and has excited—not our envy, but—our astonishment and our joy.—To say that it rivals or eclipses our own humble production in what is called “the getting up,” would be, perhaps, considered little of a compliment. The fresh zeal and exertions of a new editor, (Dr. COLE,) are not less conspicuous in the judicious selections he has made from other works, and the valuable notes with which he has embellished them, than in the host of able contributors he has summoned to his aid;—some of whom, alas! we have hitherto boasted as our own\*, but whose transfer of allegiance is but natural, when so legitimate a rival arises to claim it. The present number (four-monthly?) contains 240 pages, price only 3 rupees. Of its most rich contents we should be tempted to glean with unsparing hand, could we afford space. Dr. BENZA has another excellent geological paper on the country between Madras and the Nilgiris. Mr. COLE has done a service to geology, by an accurate definition and description of the *laterite* formation.—Mr. TAYLOR’s view of the present state of astronomical science is highly interesting. It shews, that he is not one of those who merely keep up a supine routine of accustomed observations, but that all his observatory does is directed to useful ends—to the elucidation of those desiderata in the science for which its situation is best calculated. Nor is he a *Flamstead*, jealous of giving his labours into other hands, and tardy in working out results himself; for his *third volume* of observations, reduced and classified in the most compendious manner, has just issued from the Madras press. We may be indeed jealous that our Presidency should boast no similar production, and that even the astronomical labours of the Grand Trigonometrical Survey in the northern mountains should be as inaccessible and unknown as all their other operations! Colonel MONTEITH, Engineers, whose survey of part of Persia we noticed some time since, is imparting the statistical contents of his note book, accumulated during 18 years’ residence in Persia. An account of the Thuggee system, by Lieutenant REYNOLDS—Observations on original and derived languages, by the Rev. B. SCHMID, and on the language of the Battas of Sumatra, by Lieutenant NEWBOLD, and the Rev. W. TAYLOR, are amongst the most interesting contents of this very creditable volume.

\* Dr. BENZA, Mr. T. G. TAYLOR, Lieut. NEWBOLD.

*Meteorological Register, kept at the Assay Office, Calcutta, for the Month of July, 1836.*

[illegible]

In the present month the old standard barometer has been read off with its compensation index.—The hair hygrometer has been employed in other experiments; the sulphuric acid is



